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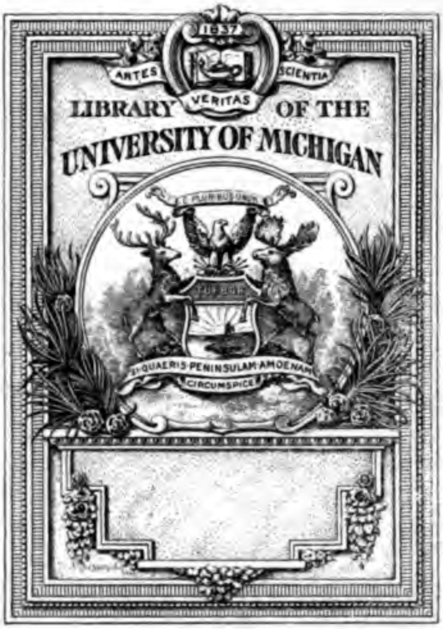

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THE

GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

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THE NINTH ANNUAL REPORT

FOR THE YEAR 1880.

N. H. WINCHELL,
STATE GEOLOGIST.

ST. PETER:
J. K. MOORE, STATE PRINTER.
1881.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

The First Annual Report of the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson: 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.

The Sixth Annual Report on the Geological and Natural History Survey, for the year 1877. By N. H. Winchell, with Reports on Chemical Analyses by Prof. Peckham, on Ornithology by P. L. Hatch, on Entomology by Allen Whitman, and on the Geology of Rice County by L. B. Sperry; three geological maps and several other illustrations. 226 pp. 8vo. Also published in the Regents' Report for 1877.

The Seventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1878. By N. H. Winchell, with a Field Report by C. W. Hall, chemical Analyses by S. F. Peckham, Ornithology by P. L. Hatch, a list of the Plants of the north shore of Lake Superior by B. Juni, and an Appendix by C. L. Herrick on the Microscopic Entomostraca of Minnesota, with twenty-one plates. 123 pp., 8vo. Also published in the Regents' Report for 1878.

The Eighth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1879. By N. H. Winchell, containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, descriptions of new species of brachiopods from the Trenton and Hudson River formations; the Geology of Central and Western Minnesota, by Warren Upham; report on the Lake Superior region by C. W. Hall; lists of Birds and of Plants from Lake Superior by Thomas S. Roberts; Chemical Analyses by S. F. Peckham; Report by P. L. Hatch; and four Appendixes. 187 pp. 8vo. One plate of Castoroides Ohioensis. Also in the Regents' Report for 1879 and '80.

II. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR NO. 1. *A copy of the law ordering the survey, and a note asking the co-operation of citizens and others.* 1872.

2. PEAT FOR DOMESTIC FUEL. 1874. *Edited by S. F. Peckham.*

3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. *A history of all official transactions relating to them, and a statement of their amount and location.* 1874. *By N. H. Winchell.*

4. A CATALOGUE OF THE PLANTS OF MINNESOTA; *prepared in 1865 by Dr. I. A. Lapham, contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.*

5. CIRCULAR NO. 2. *Relating to Botany, and giving general directions for collecting information on the flora of the State.* 1876.

6. CIRCULAR NO. 3. *The establishment and organization of the Museum.* 1877.

7. CIRCULAR NO. 4. *Relating to duplicates in the Museum and to exchanges.* 1878.

8. THE BUILDING STONES, LIMES, CLAYS, CEMENTS, ROOFING, FLAGGING, AND PAVING STONES OF MINNESOTA. *A special report by N. H. Winchell.* 1880.

9. CIRCULAR NO. 5. *To Builders and Quarrymen. Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum.* 1880.

10. CIRCULAR NO. 6. *To owners of mills and unimproved water powers. Relating to the Hydrology and water-powers of Minnesota.* 1880.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, Dec. 15, 1880.

To the President of the University:

DEAR SIR.—It gives me pleasure to present herewith the Ninth Annual Report on the progress of the Geological and Natural History Survey of the State, as required by the terms of the law creating the same. This annual report has been curtailed by the preparation of the first volumes of the final report, and some of the material which otherwise would find place here, is more properly reserved for incorporation in the final report.

Very respectfully, your obedient servant,
N. H. WINCHELL,
State Geologist and Curator of the General Museum.

REPORT.

I.

SUMMARY STATEMENT.

During the year, since the rendering of the last report, considerable time has been spent in laboratory, office and museum work. The crystalline rocks gathered during two seasons of field work in the northern part of the State, including the Cupriferous Series, the Huronian, and the light-colored granites presumed to belong to the Laurentian, have been provisionally arranged, labeled, registered and prepared for final examination. About 300 thin sections have been made for microscopic examination, and about one hundred, embracing the coast series along the north shore of Lake Superior, have been subjected to preliminary study.

In Palæontology considerable progress has been made in the determination of the *brachiopoda* of the Trenton and Hudson river formations, resulting in the identification of-

Seven species of *Lingula*, of which two are supposed to be new; one species of *Discina;* three species of *Crania*, of which one is new: fifteen species of *Orthis*, of which eight are probably new; three species of *Strophomena*, including one new species, and three of *Hemipronites*. Of these drawings have been made preparatory to final publication.

In the Museum important changes and improvements have been made. The central portion of the south room, devoted to geology and mineralogy, has been filled by the construction of a large upright case in which are to be placed the minerals, rocks and fossils of Minnesota, as fast as they are turned over for exhibiton by the survey; and already a fair representation of them has been placed on the shelves; and the contents of all the cases have been inventoried. In the north room additions have been made to the stuffed mammals and birds, and to the fishes and invertebrates, from various sources, and especially from the United States Fish Commission.

At the spring meeting of the Board of Regents a communication from the St. Paul Chamber of Commerce, relating to the building stones, clays and limes of Minnesota, was referred to the State Geologist, with instructions to specially investigate and report as soon as possible on the same, respecting their quality, extent and accessibility. Such an investigation was at once begun, and is still going forward; but a preliminary report on the same, answering immediate demands, was made to the President of the Board of Regents some months ago, which by his direction has been printed as a separate and special document. At the same time a general circular was issued, addressed to builders and quarry-men, calling attention to the matter, and asking co-operation in procuring the necessary samples of rock for examination.

Another circular to *owners of Mills and unimproved Water-Powers*, was issued, intended to facilitate the collection of information on the hydrology and water-powers of the State, for the purpose of fully presenting this important branch of the internal resources of Minnesota in a creditable form, with tables and descriptions, in some part of the final report.

At the present time progress has been made on two volumes of a final report, and one of them will be offered to the Regents during the present winter. Suitable legislation should be had concerning its publication, by the biennial session of 1881.

In regard to the field-work of the survey, this has been prosecuted constantly during the working season by Mr. Warren Upham, who has been engaged in the southwestern portion of the State mainly, and has resulted in many valuable and very interesting facts relating to the drift deposits and the economical geology of that part of the State.

During the summer and autumn Mr. C. M. Terry has been engaged in an examination of the "Lake Region" in the north-central part of the State with special reference to the hydrology of the same and the distribution of forest trees, and later he has been engaged gathering information concerning the water-powers of the entire State, in accordance with the circular already mentioned. During the fore-part of the year he was engaged in the preparation of microscopic thin-sections, and on work connected with the Museum.

Some supplementary field-work has been done by the writer in the southern part of the State, with a view to settle some geological doubts respecting localities that had already been examined; and at the same time large additions were made to the collections of fossils from the Hudson River and Trenton formations.

Drawings have been made of maps and fossils in the laboratory of the survey, by Mr. C. L. Herrick, who has also acted as general laboratory and museum assistant.

Thanks are due to various individuals who have rendered aid in carrying forward the field work, or have presented specimens to the museum, or have given information desired, among whom it is just that the following should be mentioned: Mr. O. E. Garrison, of St. Cloud, who has contributed various manuscripts and maps concerning the geology of Stearns county and the upper Mississippi; Nathan Butler, of Minneapolis, who has given information of various interesting wells sunk in the northwestern part of the State; C. E. Whelpley and W. E. Swan, for information of the same character from artesian wells in the state; T. M. Young, for written accounts of glacial formations and morainic deposits in the upper portions of the Mississippi valley; Dr. D. F. Powell, B. A. Man, and others of Lanesboro, for relics and information concerning the pre-historic mounds lately opened near that city; and to the old Winnebago chief Winnosheik of Trempelean, Wisconsin, for an interesting tradition prevalent among the Winnebagoes concerning the mounds near Lanesboro; Mr. B. Juni, of New Ulm, and Thomas S. Roberts and H. V. Winchell, of Minneapolis for specimens for the zoological department of the museum; the United States Fish Commission, per Prof. S. F. Baird, for a set (No. 46) of the Atlantic coast and other fishes, and a set (No. 37) of invertebrates, prepared by the commission; Henry Mayhew, of Grand Marais, for specimens from the northern part of the state.

The survey is under obligations to the officers of the following railroad companies for free transportation for parties engaged in the field work during the year, viz: The St. Paul, Minneapolis & Manitoba, the St. Paul & Duluth, the Northern Pacific, the Minneapolis & St. Louis, the Winona & St. Peter.

II.

PRELIMINAY LIST OF ROCKS.

The following field and preliminary descriptions of the rock samples of the crystalline formations in the northern part of the state, with their accompanying localities, will not only furnish a running, brief commentary on the geology of the country, and show the progress of the field work there, but will serve also as a reference guide in the future investigation of their mineral and chemical characters, as well as in the final description of the geology of the region. The descriptions pertain mainly to the macroscopical characters of the rock, as they appear in the field, although most of the crystalline parts of the Cupriferous series have also been subjected to a preliminiary microscopic examination by means of polarized light in thin sections. In the field-notes made respecting these specimens, are full accounts, with sketches. showing their geological relationships, which are intended for the final report on that part of the State, when the field-work shall have been completed.

The specimens here described have been permanently numbered with a brush, with blue shellac and alcohol, to distinguish them from the serial numbers of the University Museum, which are in red shellac and alcohol ; and as they will always remain at the University for study and comparison, their value will be greatly enhanced if they receive only this incomplete serial description. To this list will be added other numbers, as the work progresses, and finally a set representing the typical rocks will be chosen for exchange with other museums.

The rock samples here numbered and described were collected in the field by the writer, in 1878, though sometimes accompanied and aided by other members of the survey The collections of Messrs Hall and Upham, of the crystalline rocks of the State, have not been tabulated nor examined sufficiently for report.

From Duluth to Pigeon River.

1. Nw¼ sec. 34, near Duluth, "Rice Point Granite" and its variations: gray, hard, appearing like massive labradorite, but also contains magnetite and augite, as essentials, with accidental quantities of epidote and a chloritic mineral that probably results from change.

1. A. From the same rock, but further N. E., being from the hill in the suburbs of Duluth, (intersection of 5th Avenue E. and 7th Street), taken because of a change there introduced in the formation.

1. B. Red rock, associated with No. 1, Duluth, consists essentally of orthoclase, hornblende and quartz.

1. C. Magnetited condition of No. 1, from the iron mine, Duluth.

1. D. Globular-weathering masses, appearing like a conglomerate, from No. 1, at a point about half way between the depot and Newson's quarry, Duluth.

1. E. Nodule from 1 D., same as No. 1.

2. A finer-grained rock, of the same general character as No. 1 A., and running in the form of a dyke, N. 30° W. and separating No. 1 A. from No. 3.

3. Compact, brown, or brownish red, heavy, with spots and specks of dark green. This spreads wider and is to be seen at other points back of Duluth, yet appears rather to be in patches, or in veins in other rock. At Newson's quarry a similar red rock penetrates the gray rock in seams, and occupies a larger area in the lower part of the quarry.*

4. A light colored, weathered, fine-grained rock, having specks of green and red, a cementing material for rounded masses of No. 1, showing sometimes a stratification dipping S. E. at an angle of perhaps 10 degrees: near the depot. This rock where stratified, and nearly free from masses of No. 1, has been quarried for rough walls.

4. A. Rock like No. 4, but coarser and more crystalline, that weathers out, in rounded masses, as if a conglomerate, from No. 4.

5. Occurs at the St. Paul & Duluth depot, about 20 rods from No. 4 A. It is a coarser form of No. 1, with more magnenite, and occasional grains of quartz, and some that in thin section seem to

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*See the Annual Report for 1879, and the Proceedings of the American Association for the Advancement of Science for 1880 for a discussion of the relations of these rocks.

be orthoclase. This rock probably resulted from the complete fusion of the sedimentary beds and this mixture with the molten rock passing over and through them, as it contains some of the ingredients of both.

6. Dark green, heavy, homogeneous rock, coarsely crystalline, near the Bay in front of the Clark House, Duluth ; immediately adjoining No. 43, and apparantly overlain by it ; a wide dyke : west of Minnesota Point. Coarsely crystalline; consists essentially of a triclinic feldspar, augite, magnetite and chlorite (or viridite).

6. A. A dark-green rock finer in texture than No. 6. An extensive outcrop occurs beside the R. R. at Duluth, probable equivalent of 43.

6. B. Almost identical with 6 A, Duluth.

6. C. Fine, dark-green rock, quite amygdaloidal and porphyritic, Duluth, foot of Lake avenue. The amygdules are probably zeolitic, appearing radiated like laumontite. The red spots are stained by ferrite, and seem to be in the form of imperfect felsite.

7. Brownish-red rock, fine-grained, allied to the "red granite" of No. 1 B, and No. 3 ; belongs to the metamorphic series. Between 2d and 3d, Avenues, close to the water; underlies immediately No. 7 A: probably equivalent to No. 42, dip E. 18 °.

7. A. Nearly black, amygdaloidal, metamorphic, a short distance from No. 7; has green mineral in cavities.

7. B. Brown, porous rock, filled with concretions and amygdules ; wrought in the alley between 1st and Superior streets, and 4th and 5th avenues, East.

7. C. Coarse and dark-colored, separated from 7 A, by a joint ; a dyke ; equivalent of No. 47; roughly in line of bearing with No. 6.

7. BC. Contact rock between 7 B and 7 C.

7. D. From the dyke running toward Minnesota point; fine-grained; 6 ft. wide: has been reduced by quarrying.

8. Dark-colored, fine-grained, ground-mass carrying indistinct feldspar crystals porphyritically ; separated near the wall of contact of No. 6.

8 A. Inclusion in No. 8; very fine-grained, gray rock: in thin section shows very fine crystals of a red feldspar, probably orthoclase, like the red feldspar in 8 B and 8 C; but mainly an amorphous felsitic mass with many inclusions.

8 B. Shows the flesh-red color of the feldspar crystals, which have the outward character of orthoclase, the groundmass being made up of changed feldspar, magnetite, haematite, chlorite and other minute grains; plainly a rock resulting from metamorphism of sedimentary beds.

8 C. From a dike in No. 8, or what has the aspect of a dike, but having the characters of No. 8, both apparent and microscopic.

9. Amygdaloidal, porphyritic, metamorphic.

10. Reddish amygdaloid, but has cavities lined with green crystals like epidote, lies over No. 11.

11. Finely porphyritic and amygdaloidal; dark green, with flesh-red feldspar crystals; east of the elevator.

11 A. From a vein running in 11; nearly epidotic; but sometimes also with a little quartz.

(No. 11 is mainly a massive homogeneous rock, but in som places finely jointed, so that under the weather it parts into numerous angular blocks. In it are veins (near its eastern extension) that seem to cause a greater abundance of the red feldspar crystals in the mass of rock adjoining on either side; and also in the veins themselves are sometimes, besides the green rock material, a white quartz, and a red quartzyte or jasper that has somewhat the appearance of the red feldspar crystals.)

11 B. From No. 11. Taken from a geodic cluster of various minerals mainly laumontite. This cluster is 14 feet long and 7 broad. There are others larger. No. 11 extends along the shore about 800 feet.

12. Finely jointed, amygdaloidal, red, metamorphic shale, containing various minerals in nodules and lining cavities. extending 49 paces along the shore, east of No. 11.

12 A. White nodule from No. 12.

13. Semi-crystalline, hardened red shale, with a feldspathic base, breaking conchoidally. On weathering it shows a laminated or slaty structure dipping E. 15°. In other places it is a lumpy amygdaloid with epidotic spots and veinings; 54 paces.

13 A. A more homogeneous layer of No. 13 overlying 13. It is slightly amygdaloidal and porphyritic; has a brown color and close tough texture.

13 B. Is a still more aluminous layer of No. 13; has a fragile almost fissile structure, and a green color. It is also amygdaloidal.

14. A dyke, breaking through No. 13, running W, 10° N.

15. From a dyke 15 feet wide, running N. 25° W. accompanied by some fine pyrite and some calcite.

15 A. From the west side of this dyke.

16. Modification of 13 and 13 A, extending, (next east of the brewery) 125 feet.

17. Metamorphosed brown sandrock, having a dip 43° E; slaty when weathered; extends 20 feet.

18. Firm, rusty-green rock, finely amygdaloidal and compact, in places appearing massive or with remote joints, and in others being weathered so as to crumble coarsely like a hardened laminated shale ; over this comes down a little creek, extends nearly into the bite of the next little bay, perhaps 300 feet, and before it is discontinued it becomes more broken and amygdaloidal, the change coming on imperceptibly. The dip at the last is 26° E.

18. A. From laminatonis of light-green mineral in No. 18, embracing calcite and a waxy, honey-yellow, garnet. In the calcite are needles of apatite and in the garnet is actinolite.

19. Rock similar to No. 13 A., fine-grained, light, reddish-brown rock, compact, scarcely amygdaloidal, weathering out in small, angular, blocks, as if it had been a shale. It has scattered green, amygdules and some red feldspar crystals. This suddenly replaces No. 18 on the east and extends about 200 feet.

19. A. From a large concretion of green mineral and calcite in No. 19.

20. A tougher condition of No. 19; harsh, porous and amygdaloidal. Embraces angular masses of No. 21, and extends about 40 feet.

20. A. Fine, shaly mass, embraced in No. 20.

21. Laminated, fine-grained, jointed, metamorphic shale, extends perhaps 15 feet, overlying No. 20.

22. A fine, green amygdaloid, very much like No. 18, overlying No. 21. This extends to the prominent dyke that rises about 12 ft. perpendicularly from the lake water, forming a small promontory —perhaps 300 feet. In this are crumbling spots of green rock containing hard lumps that are more silicious and crystalline. These lumps sometimes embrace chert, or light jasper, garnet and calcite.

23. Is from the dyke above mentioned; fine doleryte, basaltic, 15 feet wide, and has a direction N. S.

24. Reddish-brown sandrock, metamorphosed, but having thin laminations of green. It is also coarser than No. 17, dip. E. 35.° — 40°. Extends 50 feet.

25. Fragile, green amygdaloid, weathering and rusting to a brownish-red: seen about twenty feet to the east of No. 24, extending 100 feet. Then comes a rocky point near the fishery, which is—

26. Somewhat porphyritic, with flesh-red feldspar crystals, fine-grained, compact, weathering green, having seams of white quartz running at angles with each other.

27. From a dyke in No. 26 which exhibits a curious change of direction. It leaves the lake in a direction E. and W., but on ascending the rocky bluff it immediately changes to W. 15° S. It runs so about eight feet and shifts again to nearly W. The rock on the east side of the dyke is the same as No. 26, and extends to the point on which is a fishery. This is number

28. Heavy bedded, bluish-gray, becoming brownish, compact, fine-grained, very firm, much like the rock of No. 27, extending with evident bedded dip about 300 feet, passing under No. 29.

29. Crumbling, light-brown rock, containing much of the green mineral so common in these beds, in the veinings and interlaminations. Its upper portion is of a light-green color: a metamorphic shale. about 5 feet thick, dip 10° E.

30. Red or brown, metamorphic shale or sandstone, dipping 12½° N. 30° E.: varying from a brownish siliceous sandrock to one that is greenish and aluminous; unconformable bedding in this rock, probably shows different epochs separated by igneous outflow in other places; one part dips but little and the other dips E. 30° S., and in amount about 15 or 20 degrees. Extends 400 feet to Mallman's dyke.

31. Fine dolerite, from Mallman's dyke.

32. Hard, black, much like the rock of No. 31, but passes upwardly but few feet (3 or 4), gradually losing its firm and hard nature, as well as its color, and becoming in the bluff (which is 25 feet high) reddish brown, and breaking into angular blocks of a few inches under the action of the weather: taken near the water on the east side of a fault.

32. A. Taken from 32, near the top of of the bluff, a weathered modification of No. 32.

32. B. From green seams in No. 32.

33. About 60 feet east of No. 32 is another fault, and this number is from the amygdaloid on the east of this fault near the lake level; massive and roughly concretionary.

33 A. No. 33 is less amygdaloidal, more dense and firm in the upper part, with patches of fragile, closely jointed rock, like an indurated shale, from which this is taken.

33. B. Taken from the stratigraphical equivalent, in the extension of No. 33 A, showing a changed condition, but one which is gradual in the nature of the metamorphism, dip remaining easterly 13°—extent 30 feet.

34. Overlies No. 33 B, and is about 15 ft. thick, the two passing gradually into each other accross the bedding. This is a beautifully specked and spotted amygdaloid, some of the concretions being white, (½ to 1 in. across), some red (¼ to ½ in.) some green (¼ in.) and some with a red center enclosed in a green coating.

34. A. Concretions from 34.

35. Is about 12 ft. thick, a hard reddish, imperfect amygdaloid, with numerous natural seams, which serve as joints and cause it to part under the hammer in small pieces without showing a fresh fracture, just west of the mouth of Kin-i-chi-ga-quag creek (or Chester creek, as it is generally named now).

36. Like No. 18, is a hard gray, or brownish-gray, fine-grained, tough rock, very much like some igneous rock ; yet its extent, dip and position mark it a sedimentary rock, though it shows no sedimentary bedding: at the mouth of Kinichigaquag creek, on the west side.

36. A. Amygdaloidal porous condition of No. 36, having an abundant green material, from the upper portion of the bluff immediately west of the creek. This porous condition occurs in layers or belts in No. 36.

37. Rock immediately east of the creek, standing up like a dyke, compact, fine, basaltiform with some large geodic concretions ; continuing E. to a real dyke 18 feet wide ; pyritiferous, extending about 4 rods.

37. A. Calcite from a concretion in No. 37.

38. From the large dyke, 18 feet wide, running N. and S; greenish-black, finely crystalline: hangs to the E. 10°. The rock to the west of this dyke has assumed the character of a dyke-rock, very much; but this is not the case on the east side.

39. Rock next east of the above dyke; a breccia, with pyrites: extent 35 ft. dip E.

40. Hard firm beds next east; like the dyke-like beds on the west of the dyke; having at first a general dip E., but showing no regularity of dip; having rather contorted and confused bedding as

if the layers of the sedimentary strata had been plastic and molded on themselves. These characters on the face of the rock are brought out particularly on the smoothed and glaciated surfaces. Sometimes there appears also a rude concretiouary structure pervating the mass. The layers of contorted bedding are thin, or about ½ to 1 in. thick, and are sometimes perpendicular and transverse, and sometimes project irregularly above each other as they are hard or soft. On freshly broken surfaces this contorted bedding is evinced by bands of different color, some of them being greenish, and some brown, and some nearly black: but yet the whole is fine-grained, compact, and of a dark gray color, or bluish-gray color. This changes in its passage across a little bay, and becomes like No. 35, when it is suddenly replaced by number

41. A heavy-dark, green, or grayish-green, basaltiform rock; crystalline, neither porphyritic nor amygdaloidal, nor showing sedimentary structure. The columns tip about ten degrees from perpendicular toward the N. E.; varies from a texture like that of No. 7 C. to a finer grain, much like 43; an igneous overflow; adjoins No. 50 on the E.

42. Reddish-brown, metamorphic rock, rising above the clay like a "sheeps' back," four blocks north of the depot at Duluth; imperfectly porphyritic with fine crystals of flesh-red feldspar, and of a dark green mineral; probably the same as No. 7. There is a succession of such exposures on the hillslope running through Duluth northeastwardly.

42. A. A concretion from No. 42.

43. Compact, bluish, firm beds in outcrop on the hillslope back from the base of Minnesota Point, in front of the engine house. Width and form of this rock cannot be made out. Finely porphyritic with red feldspar in some places and is coarsely jointed. Apparently has a dip E. 30° N. Surface rounded over by glaciation; the equivalent of 6 A.

43. A. Porphyritic portion of 43.

44. From top of the hill at the head of 1st Avenue E., very fine-grained, black, like diabase.

44.^{1} Hard, compact, fine-grained, from top of Kinichigaquag Falls; the extension of No. 43.

45. From a ravine, between No. 44 and No. 1 B, on the hill; brownish-red, fine-grained rock; a form of No. 3 and 1 B.

45.^{1} Foot of Chester Creek Falls, similar to No. 44^1, but having a little scattered mottling of red, as of feldspar.

46. Sedimentary rock metamorphosed to red porphyry; from Brewery Creek, Duluth.

46.[1] From the Weller farm road, back of Duluth, south side of the hill, showing the contact between the "red granite" of No. 1 B., of the metamorphic series, and No. 1 of the igneous rocks.

47. From an outcrop of No. 7 C, on Superior st.

48. From 2nd st., cor. 4th Av. E., close-grained and firm, hard, bluish-gray to black, heavy, not visibly amygdaloidal, but finely porphyritic. This runs from in front of C. Markell's house, where it can be seen in outcrop, under the Hayes block. It is a large member, at least 150 feet thick, and falls in the unseen interval between Nos. 7 and 6 C.

49. Igneous rock, which seems to consist principally of Labradorite, augite and magnetite, with chlorite and ferrite as products of change; from behind the M. E. Church, between 2nd and 3rd streets, and 3rd and 4th avenues west. Hand to hand samples show no outward difference between this and No. 7 C, but there seems to be no way to stratigraghically correlate, or unite them, since 7 C cannot be a stratum running to No. 49, as it would go above Nos. 7 and 43, and others. Yet 49 appears to dip to No. 6, which is roughly in line with No. 7 C, though too far north.

50. Next east of the igneous rock of No. 41; an amygdaloidal breccia, with cavities, having in the main a reddish-brown color, but associated also with much green. This at first is so broken, and even columnar in some spots, with fine basaltiform columns, that it shows no dip, but further on, and just before reaching the next point, it has a marked dip E. 10° south, in amount about 18 degrees; extent about 150 feet.

51. From a point the next one beyond the breccia of No. 50; a brownish rock, resembling No. 7, much firmer than No. 50, and lies directly over it: disintegrates in small, angular pieces, according to innumerable weather-joints. Sometimes rises 12 feet perpendicularly from the water; extent about 200 feet.

52. Is produced by a gradual transition from No. 51, which it overlies; of three heavy beds, the lower hermetically united to No. 51, and passing into it. This is fine-grained, almost black, heavy and firm. This number has an interesting aspect. Each bed is finely and closely basaltiform, the basaltic columns being rather

layers running W. 10° N., and E. 10° S., from an inch to two inches in thickness, in a positon perpendicular to the bedding. They were doubtless produced by the baking effect of the next which comes on suddenly and in a position to immediately overlie 52.

53. Coarsely crystalline igneous rock, resembling Nos. 6 and 7 C; basaltiform; an overflow, or intercalated bed in the sedimentary rock; overlies No. 52.

53. A. Decomposed rock of No. 52, of a dark green color and velvety feel; mainly chloritic; sometimes lining cavities or coating joints; has an imperfect fracture like that across botryoidal hæmatite; hardness 2 or 2.5.

53. B. A part of No. 53, containing some flesh-red crystals, making it resemble No. 5; from the longest rocky point; N. W. ¼, Sec. 24, T. 50, R. 14.

54. From a small dyke 3½ feet wide, associated with others about 40 rods E. of 53 B., cutting No. 53 in a direction N. 5°E. Some of these dykes are narrower, and change their direction, and sometimes "pinch out" entirely. Where these dykes cut 53 it has so much of the flesh-red mineral that its prevailing color is brownish-red, and has been wrought for constructing the break-water at Duluth. In the bite of another bay near E. Duluth, S. E. ¼, Sec. 13, is another finely basaltic narrow dyke, 4 feet wide, running across No. 53, the columns of basaltic structure running directly across from side to side, perpendicularly to the walls. No. 53 has here a strong resemblance to No. 5, and runs under

55. Which is from a sedimentary member of the series broken, ciated and baked, dipping N. 60° E, in the bite of a little bay at E. Duluth, continuing ½ mile (by the coast), becoming more broken, and slightly amygdaloidal, at the last, till the appearance of another bed of igneous rock. No. 55 is reddish, angularly and finely jointed, sometimes a jaspery rock.

55 A. Small concretions or cavities lined with quartz in No. 55.

56. Ferrugnious, brecciated, fine-grained, siliceous, fragile, almost fissile; a condition of No. 55.

57. Dark and heavy rock from a dyke, cutting No. 56; dyke 4 ft. wide, running N. 5° E.

57 A. From another dyke like No. 57, but ten feet wide, a few feet further E.; consistsng of a lump of calcite associated with a green mineral which is probably some form of chlorite, or delessite, resembling the green mineral of No. 53 A, result of change from pyroxene or hornblende.

58. The red rock (No. 55) continues with slight changes, rising perpendicularly, sometimes 25 feet high, to and beyond the creek somewhat larger than Chester creek, and about 80 rods east of Tisher's farm house, where No. 58 appears a little west of the town line between ranges 13 and 14 on the lake shore. This is a compact brownish-red rock with crystals of flesh-red feldspar, 15 rods. At Tisher's creek the beds are conglomeritic, standing vertical, the adjoining portions being slightly granitized.

59. An amygdaloid similar to No. 34; small outcrop in the shingle of the beach, having an apparent dip W.

60. Reddish-brown, finely crystalline, frequently jointed, hardly amydaloidal or porphyritic; from a little rocky point rising from the water, abreast of No. 59, with a straggling line of strike, and a sharp firm outline that runs nearly north inshore, having an apparent dip N. From this point as the rock composing it bears inland, the shore becomes continuously rocky and high round the bay immediately west of London. Further east this rock becomes amygdaloidal in patches, and coarsely concretionary, and finally wholly amygdaloidal largely with white calcite. This rock further east where more finely broken furnishes

60 A. Dog-tooth crystals of calcite which occur in a finely jointed or brecciated condition of 60 which occurs suddenly, like a dyke, extending up and down across the face of the bluff. This breccia is about twenty feet wide, and the characters of 60 return on the east of it.

60 B. Amygdaloid just west of the breccia containing 60 A.

61. Numbers 60 and 60 B continue to within six rods of where the bluff in an angular massive projection overhangs the water, where a change occurs, showing a dip in definite characters. This dipping rock is harsh, granular, resembling a grit, thinly bedded, grayish, weathering reddish; similar to No. 30; dip 24° N. 60° E; two feet thick in one lot of thin beds; metamorphic.

62. Returns after No. 61; like No. 60, but bedded like No. 61; metamorphic.

63. Overhanging rock, which toward the east becomes brecciated; a fine purplish amygdaloid; metamorphic; overlain by

64. A pyritiferous, green rock, in a heavy bed three feet thick, which also shows calcite and fluor, and overlies

65. Containing large calcite nodules, with chalcopyrite; evenly bedded; many jointed, brownish-red, forming bluffs of 18–20 feet.

64. A. Calcite, fluorite, and bornite, from No. 64.

65. A. Calcite, &c., from No. 65.

66. A fine amygdaloid: a modification of, though probably overlying No. 65.

67. Confused, half-baked, pudding-stone-like rock, forming the point next west of the larger creek that comes through London; rather firm and of a reddish-brown color; amygdaloidal mainly; appearing as if a siliceous rock in masses had been embraced in it, and metamorphosed with it; also has lumps of shale; some of these weather dark-green and some purplish red, or a "fawn color," and some a spotted, dirty, light yellow; in it also are nests of calcite accompanied by fluorite. Across the point runs what has the form and manner of a dyke, 6 feet wide, and the above characters, particularly the calcite-fluor nests are found in it. This dyke is of the darker colors and runs N. 50° W, and is amygdaloid itself, as if of a different age from the others. It is perpendicularly bedded, the beds running in the direction of the dyke, but is less durable than the rock through which it passes. No. 67 continues for 35 or 40 rods, and is subjected to great upheaval and flexure.

67. A. Lump of calcite and fluor from the dyke (?) just described.

68. A modified condition of No. 67 where it has been upheaved and flexed; thin-bedded, red or pinkish, hard, with their interlaminations of a translucent mineral like that in Nos. 129 and 140. From near London. This translucent mineral seems to be adularia.

69. Harsh, rather fine-grained, crystalline brown rock, forming the point next east of the mouth of the creek, not more than 6 rods from it: by its position appparantly overlying the last: cut by a dyke, N. 5° E., 3 feet wide.

69. A. On east the of this dyke this rock immediately becomes coarsely amygdaloidal, with calcite and a dark red mineral that is not quite so frail as laumontite, nor so light colored, but resembles it. No. 69 returns, making the coast, cut by occasional dykes, or modified and interbedded with igneous rock, and extends half way to Lester river. Before reaching its termination it is cut by a dyke 6 feet wide which forms a jutting high point but few rods west of the east boundary of New London. This causes no apparent change in the formation; but at the next high rocky point the beds are contorted and bent in all directions, as if the overlying rocks had been thrust against and upon them with great violence.

70. The rock that overlies No. 69, perhaps the equivalent of 64, or of a bed like it. It is a firm heavy metamorphic conglomerate, and causes a prominent point or break in the direction of the shore line. This contains quartzyte pebbles, with calcite and pyrite in the interstices, dip E. 20°N.; on the W. of Lester river.

71. One of the beds of the sedimentary formation; overlying No. 70; fine-grained, greenish rock having a reddish color along its seams. This continues but 6 or 8 rods and disappears under the beach, and nothing appears again till at Lester river.

72. Brecciated granular sandrock, or quartzyte, of a light-brown, or reddish color, homogeneous and thinly bedded, (or was so), at the mouth of Lester (or Passabika) river. The amygdaloidal structure does not pervade the sandrock, but it pervades the cement, or rock that fills the angular openings between the pieces of the breccia.

72. A. Calcitic amygdaloid, the cementing material of 72.

73. Rock from the east side, at the mouth of Passabika river. Fine-grained, similar to No. 71, crystalline, non-amygdaloidal, of a dark gray color, becoming brown along some of the joints, and in some large areas; Extent 1½ miles, with a low line of exposure; runs under No. 74.

74. Red rock next east of No. 73, extending for some distance; rather coarsely granular, changed from the sedimentary beds; cut by a dyke 25 feet wide running N. 10° E; afterwards a breccia, followed by a rock like No. 71 again. This last shades through various modifications into an amygdaloid, and thus continues to a point where some mining has been done for copper S. E. ¼ Sec. 34. T 51 N. R 13 W.

75. Porous, almost spongy, with laumontitic amygdules; from No. 74. At this locality there has been an unusual disturbance of the beds, all of them being converted into a breccia, yet with enough of the original lamination preserved to show the direction of the strike and dip. The layers stand nearly vertical, or dip at a high angle to the north, with flexures, the strike being nearly east and west. Colors vary from a light flesh-color to a brownish-red. The latter color is amygdaloidal, the former is more apt to be brecciated merely, or evenly bedded, or to be spongy likethe samples taken.

76. Directly lying on No. 75; resembles No. 71; interbedded with No. 75; containing laumontite amygdules, and nodules of calcite and fluorite; having somewhat a trappous aspect; runs under—

77. Which is the rock wrought for copper; a coarse amygdaloid with laumontite and calcite, containing some copper.

78. Firm, brownish-red, crystalline, or sub-crystalline, like some other numbers, forms the bite of Crystal Bay, often bedded, much jointed, disintegrating and falling in large loose masses, weathering light red or pinkish; containing nests of calcite crystals, showing perfect, sometimes double, terminations; these nests are sometimes 18 inches across, but generally less than 10. The crystals are impacted in a fine red clay which, with the crystals, are included in the cavities; the clay is laminated, and may have been infiltrated from above.

78. A. Crystals from No. 78.

79. Finely crystalline, of a brownish color, and basaltiform in jointing; but with this rock, which presents many characters of interbedded traprock, are seen also evidently metamorphosed sedimentary rocks, sometimes amygdaloidal and sometimes close and compact, sometimes highly tilted (generally to the east or southeast), and sometimes nearly horizontal; sometimes also presenting a false cross stratification, or false bedding, like some sandrocks. Samples represent the prevailing variety of rock along the coast from No. 78 for a mile or more, the bluffs being generally low—3 to 10 feet—with great confusion. With the various scenes of disturbance, upheaval and contortion along here it is impossible, with the various metamorphic effects, and the mingling of true igneous rock, to trace consecutively any formation but a few rods.

80. Samples of prehnite and cupriferous prehnite from the shaft about one mile up French river.

81. Trappous rock, dark, somewhat amygdaloidal; amygdules dark, or of the color of the rock. This rock decomposes into rounded grains or amygdules, becoming lighter colored. This continues to form the bed and bluffs of the creek for ½ mile or more, when it begins to show light amygdules of laumontite, of which

82 is a sample, appearing much like No. 81, and is really only a variation of 81. The same rock (81) continues, with some variations, to the mine of the French River Mining Company, where the road from Duluth crosses the creek (sec. 18). At this mine the copper occurs native in the rock that seems to run in irregular veins and crevices in the rock No. 81, which has the appearance of being an igneous rock. The ore (No. 80) consists of a gray-colored radiated prehnite, in cavities and veins in No. 81.

83. Heavy gray rock with geodic cavities lined with prehnite, also having laumontite.

84. Highly amygdaloidal rock from 1½ miles up French River. (Hall.)

85. A coarse loose rock easily crumbling under the hammer; yellowish white concretions. (Hall.)

86. Fine, hard, crystalline rock with chalcedony (?) concretions about two miles up French River. (Hall.)

87. A fine dark rock with no bedded srructure, at three miles up French River. (Hall.)

88. SW ¼ Sec. 10, on the lake shore; from the round point which bounds Sucker Bay on the west. Rock similar to that at French River forms the coast for about ½ mile, having a low outcrop. It is gray, heavy, amygdaloidal, the amygdules being of nearly the same color as the body of the rock, but in some patches amygdaloidal with a flesh-red mineral, harder and darker than laumontite, as at points west of the creek crossing secs, 9 and 10, sometimes thinly bedded and disintegrating.

89. Just east of this creek the exposed rock becomes heavily bedded and darker. Norwood here calls it a dyke, but it seems to be rather one of the heavy massive beds of igneous overflow, similar to those of Agate Bay; non-amygdaloidal, rather fine-grained, but having large geodic concretions of calcite, with an interior of laumontite. The joints are lined with a mineral Norwood styled heulandite. See Nos. 515 and 516.

90. From the east point of Sucker Bay, a massive, heavy-bedded, dark rock, sloping up from the water's edge, similar to Nos. 1 and 49; continues to Knife River; also forms Knife Islands.

90. A. From a conspicuous white seam or vein in No. 90, which strings and splits out in ascending the face of the rock from the water; spongy and apparently siliceous, but too soft to be of quartz.

90. B. Concretions from No. 90.

91. Rock from the east side of Knife River, passing under the rock of the point (No. 90); with amygdules of white minerals, some of which appear to be quartz, but many of them are of an amorphous white mineral which on weathering is slippery, This white mineral is also harder in seams and in some of the amygdules. (Same as No. 641.)

91. A. Represents the harder amorphous white mineral; but closely mixed with the soft.

91. B. The soft white mineral which Dr. Owen named thalite, placed by Dana under saponite.

91. C. Is from a spongy mass from near the center of a large concretion in No. 91, at least 3 feet in diameter, the whole concretion being at least 6 feet through; this spongy mass is largely made up of laumontite, and in some places it is rusty. There are spots in this rock (No. 91) which show clear quartz crystals, forming the nuclei of the amygdules, especially where the concretions are about ¾ inch or an inch in diameter, with the amorphous white mineral surrounding them; crystallized in these concretions are also found calcite and laumontite. This passage from quartz (in the centre) through amorphous hard mineral (opal?) to saponite suggests a posible origin for agates; viz: the dissolution of saponite and its losing $A_2l\ O_3$ and MgO, leaving the SiO_2 to crystalize in the centre. This 91 B (thalite of Owen) makes the main material in the amygdules of the amygdaloid ¼ mile, east of Knife River, and as they are soft and weather out, the rock easily disintegrates. It is found also in veins and seams and in angular crevices.

92. Laumontitic amygdules, from about half-way between Knife River and Agate Bay. The rock No. 91 becomes more and more charged with laumontite in passing toward the east. In patches, and in some of the irregular beds of the rock, which is tipped and twisted in opposite directions, but mainly dips toward the lake, this laumontite is so abundant that the rock easily weathers to pieces. It there also is thinner and more regularly bedded, and forms the re-entrant angles of the coast, the "points" being formed by the more firm heavy-bedded trappous-looking portions of the series; when near the water-line these soft patches cause purgatories. These two variations cause a jagged, though nearly straight, coast-line for three or four, or more, miles from Knife River, in some places the rock rising about 30 ft. perpendicularly from the water. This even-bedded rock, with much laumontite, seems to be that which Norwood styled "volcanic grit," and on the southern shore is styled "ash-beds" by the miners. The "dykes" which Norwood mentions must be the firmer, broad patches and bedded sheets of more trap-like rock which occur in connection with the

amygdaloids just mentioned. There is no regularity, however, in the occurrence of these places. While this laumontite increases in quantity the thalite disappears. With the laumontite is crystallized calcite so that nearly half of the white masses that blotch the bluffs is often calcite.

93. From the firm, heavy, trappous beds, non-laumontitic, occurring as above with No. 92. At the point at which the samples are obtained (Sec. 10, T. 52, R. 11), the trappean bed, 7 ft. thick forms the height of the bluff, within a narrow bay, but overlies a bed of six feet of very laumontitic amygdaloid, which is also brecciated; under that (9 ft. to the water) is a rock that has an outward resemblance to No. 91, but has less of thalite and more laumontite.

93. A. The lower rock, last mentioned, with green (chloritic?) amygdules.

Through section 11, where a number of creeks come in, the shore is made of red clay, with a stony beach. The last rock seen is a low exposure of No. 91.

The west coast of Agate Bay is made up of a number of alternations of agatiferous, heavy beds of igneous origin, rather fine-grained, and layers of soft laumontitic, thinly-bedded amygdaloid, styled volcanic grit by Norwood. For some distance after rounding the point the coast-line is made, as noted, by a sloping rock-surface that rises directly from the water, the waves washing over a broad surface. This is taken for an igneous rock, but occasionally, before it breaks up, on entering the bay further, the overlying bed of laumontitic layers may be seen slightly under the soil, and tree-roots, or forming a continuous line of outcrop. The dip slightly changes in rounding the west point of Agate Bay so that in passing along the beach, in either direction from the long smooth rock-beach, one steps on lower layers. Within the bay the dip is nearly east. On the point, where first exposed, the dip is nearly south. Further within the bay other beds of alternating trap and amygdaloid are found to enter the coast-line, there being no less than five alternations which are numbered from above, below as follows, in the samples collected. These beds vary from eight to fifteen feet thick.

94. Trap, from the top of the bluff. Agate Bay.
95. Amygdaloid, underlying No. 94.
96. Trap, underlying No. 95.
97. Amygdaloid, underlying No. 96.
98. Trap, underlying No. 97.

99. Amygdaloid, underlying No. 98.

100. Trap, underlying No. 99.

101. Amygdaloid, underlying No. 100.

102. Trap, underlying No. 101.

103. Agates, veinstones, geodes, &c, from the layers at Agate Bay.

The point between Agate and Burlington bays is made by a succession of seven layers of traprock, alternating with loose, sometimes brecciated, amygdaloidal layers, while five are seen in rounding the corresponding point on the west side of Agate Bay; the firmer beds forming sharp rocky points, and the amygdaloid occupying the inward angles. They are each 10-15 feet thick and dip eastwardly, as on the west of Agate Bay. These cannot be distinguished from those already enumerated on the west side of Agate Bay. Burlington Bay is structurally a repetition of Agate Bay, whether by the same beds or not is uncertain, but quite possible; the general dip of the beds being toward the lake, about both bays, particularly on the westerly sides where, by the operation of high seas and winds, the rocks have suffered greatest degredation. The eastern shores of these bays are mostly made of pebbles and debris, and are low; yet it seems as if the rocky substructure were the governing cause of their westerly slopes. Hence these bays are due to a sort of trough-like downward sweep of the layers of trap and amygdaloid, within the bays, and the points to a similar upward sweep, the greater rock exposure on their westerly coasts being due to the greater erosion on eastward facing shores. The eastern shore of Burlington Bay, and the point, are constructed in the same way of alternating layers of soft and hard rock, the whole more or less igneous or vesicular. Near the extremity of the point is a remarkable instance of a heavy trap bed supported on buttresses of softer amygdaloid which separate deep and dark purgatories to the number of thirteen. The trap bed, which lies like the superstructure of a bridge on piers, is about ten feet thick, and the whole rises 25 or thirty feet towards the west, but descends gradually to the lake level towards the east.

104. Seems to be what Norwood styled heulandite, from the igneous layer that lies along the lake level at the great bridge, below the amygdaloid.

The bay next east of Burlington Bay is also made up along its western coast of a succession of heavy, dark, igneous beds, alternating with soft amygdaloids, the number of the former being four or five.

105. Sec. 22, T. 53, R. 10. The point on the coast here just E. of Silver Cr. is high and rocky, with mixed dark heavy rock and amygdaloid, as if from a conglomerate, rising about thirty feet perpendicularly from the water, and particularly on the eastern side. Along Sec. 21 the coast is low and rocky, with trap and amygdaloid, dipping generally into the lake, but through Sec. 29 it is mainly a shingle beach. The hill on Sec. 15 is abruptly elevated, facing the lake, (See 639) and caused by mixed trap and amygdaloid. It rises perhaps 250 feet above the lake, and further back about 400 feet,. the top being of heavy basaltic doleryte. The whole coast line of Sec. 15 is high and rocky with this number—alternating or mixed amygdaloid and trap, with purgatories in the former. Sec. 11 is mainly a sand beach, with no rock, or only a single low rocky point, ½ mile west of Encampment River. This sandy beach continues to the middle of the coast line that is in Sec. 12, when trap and amygdaloid return, extending about ten rods after which appears the next.

106. A heavy, coarsely-jointed, coarse-grained rock, of which Encampment Island is composed, a truly igneous rock, in which the augite (?) shows metalloidal surfaces resembling bronzite. This also contains what is taken provisionally for the *unindividualized magma*, as well as plagioclose, magnetite, apatite and delessite, (same as 638). This rock also has concretionary or geodic nests of light-colored mineral resembling quartz or chalcedony.

107. From the point directly opposite the island. It is heavy, dark-colored, massive, but basaltiform, overlying a red amygdaloid which lies on a rock like that of Two Harbors. This rock seems to be an extension of the rock of Encampment Island, and the equivalent of No. 639.

108. Heavy trap, showing small grains or films of native copper, from the high bluff at the mouth of Gooseberry river. (See Nos. 517 and 518).

109. Trap from the falls of the Gooseberry river. S. W. ¼ Sec. 22, T. 54.9

109. A. Thalite &c., Falls of the Gooseberry.

110. Reddish, finely-jointed, and crumbling into many small, angular pieces, that on the beach are firm, red, and abundantly strewn

of Gooseberry river. This rock, which is seen about on Sec. 12, T. 54.9, is like that at Crystal Bay, which furnishes the calcites. The for some miles west. even making the red beach at the mouth bluff here gradually rises from the level of the lake at its western end, with a dip (?) almost perpendicular, but toward the west. In passing along 20 rods it gets horizontal, and even runs the other way, at an angle of 25 degrees. The perpendicular bluff rises 40 feet in its horizontal parts, and where the dip becomes 20° E. it is somewhat higher, continuing altogether about 40 rods. (V. 520.)

Nearly opposite this bluff is a rocky trap island in which are numerous concretionary masses which themselves are mainly of the same rock, 3 and 4 feet in diameter, and also many nodules of quartz, some of them being a foot or more in diameter. They are geodic and sometimes amethystine or agate-like. This trap is finely amygdaloidal in some places, but generally heavy, compact, and dark-colored; the two characters being disseminated so as to be irregularly mixed, one surrounding the other as if in concretions, or as if one had been cemented in the other as a matrix. This rook can be traced in the shallow water, directly under the rock of No. 110, up to the foot of the bluff on the mainland. There are here strictly two small islands separated by a narrow shallow channel. The rock of these islands, and the beds of the coast west of the rock of No. 110, rise toward the west so as to form the high land and bluff at Gooseberry River from which was obtained No. 108.

111 A. Heavy compact trap. Sec. 7, T. 54, R. 8.

111 B. Amygdaloidal trap. Sec. 7, T. 54, R. 8.

These are from the west side of a little bay in Sec. 7, one showing 10 feet and the other 6 ft. They are both greenish. The strike is nearly northward :and northeastward, but forms the coast-line for ½ mile, No. 111 B, gradually rising to a thickness of nearly 15 feet, when it passes inland as the coast-line, made of shingle, sweeps more eastwardly toward the mouth of Splitrock River.

112. Dark basaltic trap, holding masses of No. 113, from Splitrock Point. (V. 524.)

112 A. Vein rock, and calcite and stilbite (?) from a vein in No. 112.

113. Feldspar rock, probably labradorite, from the masses included in dark trap at Splitrock Point.

The west side of Splitrock River, at its entrance to the lake, is low, but the east side, or northeasterly, is high, and formed of a basaltic bluff of rock like No. 112, which appears on the immediate coast at a short distance east of the river. It there embraces a large block of a whitish-looking rock, which at a distance appears to be granite, but which in reality is what has been described by Norwood as feldspar (No. 113), protruding through greenstone. This does stand up like a dyke, but is in reality older than the trap, and occurs generally further inland, forming hills several hundred feet high. This bluff rises sheer from the water 136 feet, and has basaltic dark trap on each side of it, the rock itself being massive. On the east of this high rock the trap shows included masses of the same rock, a fact which Norwood mentions, but yet speaks of the feldspar as a protruded mass of later date than the trap. On the west of the large feldspar mass is a vein in No. 112 eighteen inches wide, mostly now consisting of calcite (112 A), with coating of stilbite next the walls. (V. 522, 523, 524.)

114. Massive dark doleryte, occurring under the feldspar mass, and to the east of it. (Hall.)

115. Massive dark rock holding feldspar blocks. (Hall.)

115. A. Feldspar found in No. 115. (Hall.)

115. B. Vein running through the rock No. 115. (Hall.)

On east of Castle Danger (No. 113) there is a huge pudding stone of trap and feldspar for a short distance, and then under it is a short exposure of rock No. 110, just as the bay begins, which on the opposite side of the bay, east of Splitrock Point, appears again at the foot of a high bluff of feldspar rock which stands a little inland. Compare No.'s 522 and 523.

116. Rock on next bluff below the feldspar rock, and resembling rock 115. Point rises high, and is basaltic in structure; about half way between Splitrock Point and Two Harbor Bay. There is a conspicuous basaltiform layering on the east side of this point which slopes eastwardly.

117. The Two Harbor rock; a heavy fine-grained compact, brownish-black, bedded rock dipping eastwardly; in some places coarsely crystalline and reddish, containing small quartz geodes and crystals: these red parts sometimes cross the mass in the form of veins. In order of stratification this underlies the rock of No. 116, but is separated from it by Nos. 522 and 523, the stratigraphical equivalents of rock 520 and 110. It is one of the sedimentaries.

118. Crystalline igneous rock, of coarse texture, from the conical hill at the head of Two Harbor Bay.

The point that encloses the east side of Two Harbor Bay is a repetition of Castle Danger Point (or Splitrock Point), and is made up in the same way of a dark basaltic doleryte and blocks of gray feldspar; but here the rock No. 117 can be seen lying below No. 112. A little east of the perpendicular part of this bluff, yet before the detached masses of feldspar cease, can be seen a large smoothed surface of one of the feldspar blocks, uncovered by the falling off of the basaltic columns, presenting the characters of glaciation. The piece is 30 feet long and stands somewhat obliquely among the basaltic columns. On the main part of the striated surface the marks are large and wavy, and run obliquely upward at an angle of about 45°, as the surface slopes. The whole contour of the wall which is exposed over 20 feet of height, and ten or fifteen in width, is exactly that of the glaciated surfaces, being smoothed and marked transverse to the coarse jointing of the block, the face being toward the S. W. The striations and the whole smoothed surface run continuously directly under the basaltic columns of the trap that still stand in their places. If these be glacial marks, they furnish evidence of a post glacial, or an interglacial, igneous outflow. Still the marks can be accounted for, perhaps, by refering them to the slow action of the weather under the pressure of the slowly disintegrating basaltic trap. As the several columns became loose, but did not fall into the lake, their pressure, by gravitation, on a sloping hard surface, with alternate freezing and thawing, might so raise and lower them as to cause them to operate as slowly moving boulders frozen in a glacier.

119. At the next high point, about half a mile, the rock is reddish and basaltic, being like the red granite at Beaver Bay; with a couple of narrow dykes, closely resembling the red parts of No. 117. The dykes are compact and green. Immediately east of this, which rises about 50 feet, the latter, green trap, more coarsely grained, returns, in the form of a dyke at first, but soon as heavy beds of basalt, forming high shores, for ¾ mile; thence eastward to Beaver Bay the same rock forms the coast-line. This point (119) is composed of a sudden upheaval and metamorphism of both the rock of No. 110 and No. 117, the latter being basaltic and making the promontory point. It is red. The cause of the upheaval is seen immediately on the east of the point in the outburst of heavy drak trap which runs along and rises perpendicular about 30 feet —60 feet at the next point, and appears gray. This igneous rock

extends, in the form of a dyke, or overflow, toward the north and northeast, forming a range of lakeward sloping hills running back of Beaver Bay and supplies the iron-sand of Black Beach, three miles west of Beaver Bay. At Beaver Bay Point it embraces masses of feldspar rock again, and is suddenly replaced by a high and semi-basaltic promontory of red rock (No. 526.)

120. Feldspar rock, Beaver Bay. Resembles No. 1. (See 627.)

121. Coarsely crystalline rock from W. side of second small bay above Beaver Bay entrance. (Hall.)

122. A "greenstone;" columnar, and on inside and east side of same bay as No. 121. (Hall.)

123. Resembling No. 116 from bluff east of Castle Danger. (Hall.)

123. A. Block lying within No. 123 (Hall.) See 637.

124. Brownish rock forming the bluff at Beaver Bay entrance, on the west side (Hall); much jointed, semi-basaltic, supposed to be the equivalent of No. 119 (V. No. 526.)

124. A. Dyke-rock, within 124. (Hall.)

125. S. E. ¼ Sec. 2, T. 55, R. 8. Soft, reddish, amygdaloidal; explored for copper. Several test-holes and surface trenches have been dug on various sides of a conical hill made up of alternating layers of reddish brown firm rock (trap?) and soft amygdaloid, very much like the layers that form the hill west of Agate Bay. This amyglaloid is so soft when wet, and so fragile when dry that it can be crushed in the hands. It has a soapy feel, and a dull red color.

126. This rock, which furnishes by its disintegration the black sand at Black Beach, a few miles west of Beaver Bay, is found in places about ½ mile up the creek that enters the lake there, near the center of Sec. 22, T. 55, R. 8. It seems to consist of plagioclase (labradorite?) hypersthene and magnetite essentially, making the rock hyperyte, according to Dana's Mineralogy p. 210. The metalloidal surfaces of the crystals in this rock resemble those of the rock of Encampment Island.

127. From near the mouth of the river at Beaver Bay. A metamorphic rock presenting another condition of No. 124; frequently jointed, breaking so easily along predetermined planes that it falls, under the hammer, into small fragments, making it difficult to get a fresh fracture. In the main it is slaty, but its texture is tough and its exterior is angular. It is ashen-gray, but has, between the laminations thinner lighter laminations of appar-

ently siliceous matter; suddenly rises in a knob and disappears under the drift. In color, structure and texture this differs from any rock before seen on the shore. It rises about 60 feet and extends about 120 feet. Microscopically it appears to consist of quartz in fine grains, in a non-crystalline base. It extends more or less back from the mouth of the creek, toward the west, and appears slightly on the other side of the creek. (V. 528)

128. Feldspar crystals, weathered out of masses embraced in a crumbling doleryte, just north of the mouth of Beaver Creek. These feldspar masses lie within 15 feet of another outcrop of upheaved rock like No. 127, viz:

129. Similar to 127, but porphyritic with orthoclase, and translucent grains like adularia, thus resembling the rocks 68 and 140; an isolated buttress 55 feet wide and 25 feet high. This outcrop has no evenly laminated arrangement, but is frequently jointed and easily falls to pieces. It seems to be highly tilted in the form of a bed toward the south, and lies on the next, with an angle of 30 degrees. Occurs a short distance northeast of the mouth of Beaver Creek.

130. Finely siliceous, quartzyte, dark brown, a bed lying under No. 129, suddenly thrust upward, and presenting somewhat the outward form of a dyke.

131. Finely crystalline, of a bluish gray color or nearly black; from a point 6 rods further along (N. E.) in Beaver Bay, which embraces masses of feldspar; probably of the igneous series. This rock cannot here be said to embrace the feldspar, but the overlying trap is so mixed with feldspar pieces and is so nearly of the same color and rate of disintegration that they lie confusedly together; and in some cases pebbles of feldspar, somewhat changed, are in the surface of No. 131. (See 532.)

131. A. Stilbite incrustations from No. 131.

132. The green igneous rock that holds the feldspar masses, as in 131; generally basaltic. This is apparently from the same as No. 131, but at another point. (See 532.)

132. A. Red patches, &c., in No. 132; apparently consisting largely of stilbite, of a flesh-red color, and pierced by needles of light green mineral, which is probably actinolite. This occurs in nodules and patches, in veins and joints, going in different directions across the face of the rock.

133. The coast to the first island east of Beaver Bay is made up of the coarse doleryte 132, and feldspar rock. The island in the bay is of red rock, resembling the rock in the bluff of the west point of the bay, but approaching the rock of the high palisades. This number resembles the 2d island (large one). It is of the feldspar rock, or "Rice Point granite" entirely.

134. Red granite, generally basaltic in structure, but in places amygdaloidal and crumbling; coarse grained, from the 3d island from Beaver Bay. The 4th island appears to be of the same, but was not visited. Nearly opposite the last, but a little west, is a high bluff of brecciated or amygdaloidal reddish rock with one narrow E. and W. dyke. Another dyke forms an isolated ridge a few rods further east, rising a few feet above the water and running into the sand beach in the same direction.

135. A reddish-brown breccia, sometimes amydaloidal, with traces of carbonate of copper (?) and numerous calcite seamings. From the last mentioned dyke the coast becomes jagged, rocky and precipitous, with frequently jointed, reddish-brown rock, like the Two Harbor rock, which sometimes becomes grayish like the slaty quartzyte at Beaver Bay, and this becoming brecciated and amygdaloidal, with purgatories, for nearly a mile. Opposite this precipitous line of coast is the 5th island, and No. 135 is obtained along this high bluff (20–60 feet). It is evident along this high bluff that the hard gray rock of Beaver Bay is a variation simply of the reddish-brown losely jointed rock, since it shows in patches, and especially in proximity to the E. and W. dykes; and that the fine grained, reddish-brown rock, resembling some trap, as that of Two Harbor Bay, is altered, brecciated, and basaltified by the coarse-grained, igneous rock which is associated with it, the former being one of the sedimentay beds. Between Beaver Bay and the Great Palisades are numerous feldspar masses, in the coast series, and inland from the shore a very short distance is a range of low hills made up of feldspar, with traprock on their flanks.

136. Comes from opposite the 5th island. It is a crystalline rock, with much green mineral; varies from dark-brown to greenish and black. In close proximity to it, and at last forming the whole of the bluff mentioned, is a rock that is like No. 134. This

sometimes is bedded and slopes up from the water, at other times broken and basaltic, with high bluffs. Further along the rock No. 134 seems to be surrounded and embraced in masses in No. 136, very much as the "feldspar" is embraced in No. 112, but with much less contrast of color. This is due simply to variation in the same rock.

137. Samples shows the alternations of color between bright green and bright red in the rock No. 136. The green tint is caused by abundant chlorite. (?) The red is apparently that of a dark, flesh-red feldspar but also due sometimes to iron rust. Through them both are coarse crystals of what often appears to be amphibole. In the chlorite (?) are small quartz crystals with two perfect terminations. This is opposite the island, or about the center of Sec. 28, T. 56, R. 7, in a high bluff along the W. side of a little bay of which the east is of the same rock less high. The brightest colors and contrasts are near the water.

138. Rock from the tip-top of the Great Palisades, 315 feet above the lake; a hard, reddish-brown, fine-grained rock, with translucent rectangular crystals; sometimes porphyritic with a flesh-red feldspar.

139. So taken as to express the character of the rock of the bulk of the Palisades; of the same character as No. 138.

The Palisades begin after passing the little rock-bound bay of No. 137. Altitude of the perpendicular bluff near the mouth of the Palisade Creek, 125 feet; of the Palisades near the north line of Sec. 28, back from the bluff 145 feet, separated from the main Palisades by a slight depression. Highest point on the Palisades, 315 feet; highest perpendicular over the lake, 210 feet.

140. This number embraces a varied lithology, taken from the contorted concretionary and amygdaloidal parts that lie under the main basaltic portions of the Palisades. It is by the easier erosion of this that the face of the Palisade bluff gradually recedes inland. As they become unsupported, column after column of the bluff slides down perpendicularly and generally breaks into large blocks which remain and make a breakwater protecting the lower beds from the force of the waves and ice; but sometimes they remain standing partially erect and unbroken, after sliding down, leaning against the bluff. One can now be seen so standing, about 25 feet long. In this underlying portion there is apparent a degree of heat which was sufficient to fuse, or semi-fuse the material, and to allow of its being twisted and recurved so as to defy description.

Large, hardened masses or concretions occur in it; the whole of it contains the translucent crystals mentioned, as well as flesh-red feldspar. Some of it is red, some green, some brown, some dirty white or buff; some is laminated with thin laminae of the translucent mineral, and some is massive with a conchoidal fracture; the matrix of the crystals, and the parts between the translucent laminae are not crystalline but seem to have been perfectly molten once to allow for the crystals above; yet probably cooled rather suddenly; these laminated parts and other (brownish) streaked portions, appear to have been drawn out, at least the latter, in a streamed structure, containing less of the translucent grains and more quartz, which latter is clouded, under the microscope, with inclusions. This streaked structure is judged to be due to streaming from the occurrence of a few crystalline forms in it, which perhaps would not be the case if the structure were due to a preserved effect of original sedimentation.

141. Dark green igneous rock, like 112 which holds the feldspar masses. This *seems* to lie under the Palisades, as it comes in at once on the coast east of Palisade Creek, the rock of the Palisades suddenly disappearing with dip toward the lake; continues to near Baptism River, where a coarsely jointed, brecciated, grayish-red laminated and finely porphyritic fine rock comes in just before reaching the river, through which the river has cut a narrow passage or gate as it enters the lake.

142. From N. W. ¼ of N. E. ¼ Sec. 4, T. 56, R. 7, on Baptism River, 335 feet above Lake Superior; and about 30 rods above the fourth falls of the river. About ½ mile above this the river, and the country generally, undergoes a marked change, the former becoming slow and broad, and the latter level or undulating, without visible rock in either. The rocks here consist of alternations of trap, or basalt, with amygdaloid, similar to the layers of Agate Bay, dipping N. W. 20°. The lower beds of basalt form shelving points and bars across the river, but the upper ones are in the bluff on the west side, which is 35 or 50 feet high. There are at least 16 beds of basalt, more or less distinct, but they are not so thick as at Agate Bay. Here they are from 3 to 5 feet thick, and all dip in the same direction. The fourth fall is made by one of these, more coarsely crystalline than the others

143. The doleryte that forms the fourth fall of Baptism River. The fall embraces the whole river in one narrow cleft, and descends nearly perpendicular.

144. The river bed is then filled with large boulders of No. 143 for some distance, and all dip and strike are lost. The next that appears is a closely jointed dark rock, sometimes having red belts, and calcite seams, but mainly black. In this kind of rock is an abandoned exploration for copper, some distance above the fourth fall. There is also in the river bed along this place, large detached masses of feldspar rock.

145. The rock of the third fall, which is the same as the Palisade rock, as it apppears on the shore below Baptism River. It is reddish and compact with small translucent crystals. It is somewhat finely amygdaloidal, and weathers into rough slates, which are again cut by joints into lenticular pieces, that present their sharp corners as their neighbors fall out. These slates have a dip north. Indeed the rock No. 145, so far a it appears along the river here, has shown a dip northwardly, but only occasional exposures occur, generally low and water-covered. The rock here rises above the top of the falls about 30 feet, the whole height being 105 feet. Below this fall are large masses of feldspar rock loose. There is a series of amygdaloid and trap beds under the rock of the falls, that appear in the river about 25 rods below, dipping N. W., as the rock of the falls dips. The thickness and number of these underlying beds cannot be seen.

146. Forms the rock of the second fall, but the fall is in two parts. These are simply some of the layers of the trap that belong to the series, but are coarser and somewhat basaltiform. The blocks are coarser than they are generally between the second and third falls, though there is not much exposure along the river. This fall is about 30 feet. The samples come from the top of the first part of the fall. The beds are more compact in the lower portion of the fall; but all maintain the same dip, though in less degree.

About one-fourth mile below the second fall is a bluff along the right bank, rising about 80 feet, made up of layers of trap and amygdaloid, while the left bank is low, or gently ascending, and rises up as a trap layer rises in dip at an angle of 15°, the dip being toward the west, 15° N. This continues about ¼ mile. The layer that forms the left bank, and slopes into the water is hard and fine-grained, but somewhat amygdaloidal in places with laumon tite.

147. Compact, but amygdaloidal with laumontite ½ mile below the second falls of Baptism River; from the layer sloping into the river, as above described.

148. At the first fall, the dip changes from N. W. to S. or S. E. This number represents the lowest bed, over which all the other layers seem to fall in anticlinal. Although at the brink of the fall there is more or less basaltiform structure, there is no apparent dyke. In spots the dip is in different directions, between N. W. and S. E. or S. passing through W. as if by a quaquaversal toss the whole had been twisted. The bluffs are about 100 feet high below the fall.

149. About ½ mile below the 1st falls is a conglomerate outcrop on the east bank, dipping with a synclinal bend, 10° S. by 10° E. This is isolated from all other outcrops seen above, and the dip of all seen would cause this to overlie them if there be no other irregularity. The exposure runs about 12 rods along the shore, but its highest point is at the upper end where about 18 feet can be seen. The whole of it is red, and some of it is almost wholly free from pebbles, so as to be a red sandstone, but the greater portion of it is full of pebbles. Above this point a few rods some sand rock pieces can be seen in the river. Some of the pebbles are six inches across, but generally they are smaller.

150. Basaltic rock nearly in contact with No. 149, but so separated from it by debris of pebbles, etc., that its strategraphical relations to it cannot be seen. This is coarse doleryte.

151. A short distance further down, a rock appears which occupies the bed of the river at first, but gradually rises so as to form high bluffs. It is reddish-brown, porphyritic, compact, and has translucent crystals in form of rectangles as before mentioned, resembling the palisade rock.

152. Finely jointed, compact, basaltic, forming a precipitous, high shore on either side of the river, letting the river down to the lake level. This is dyke-like in character of rock, but confused and brecciated in outward aspect, forming irregular knobs and and escarpments. This is found after an interval of non-exposure in the river bed, after the last.

153. A contorted or brecciated, slaty, closely jointed and laminated, reddish-brown rock, forming the "gate" by which the river enters the lake, rising in bluffs suddenly at the lake shore and shutting in a bayou in the river. This is also porphyritic, and has translucent square crystals. There is an outcrop of the Beaver

Bay gray, slaty, quartzyte on the right bank below No. 151. Rock like No. 141 is seen first above the bayou, just below No. 152, in a short exposure like a dyke.

153. In the little bay first east of Baptism river. Beds of reddish-gray, slaty quartzyte, like those of No 127, cut by narrow, finely-jointed dykes, the upper portion being hardened and blackened so as to resemble the second rock appearing up Baptism river (153).

The little bay next west of the red point of rock (Palisade No. 2), is occupied by high, rocky bluffs, consisting of alternating amygdaloid and basalt layers, dipping N. W. The basalt beds are from 5 to 18 feet thick and the amygdaloid from almost nothing to 15 feet. The basalt beds make little points, and the amygdaloids form bays with purgatories. These beds run under the rock of the Palisade No. 2 (No. 154), which here rises perpendicularly in a high wall facing south.

154. Rock from the Palisades No. 2, a short distance east of the mouth of Baptism river; undistinguishable from that of the Great Palisades.

This Palisade rock continues easterly with irregular dip and bedding, and sometimes evident jointing, 18 to 30 feet high, for about half a mile from this point, where a layer of dark green doleryte of basaltic structure, twenty feet thick, is seen crossing the face of the bluff in a dip 30° E. of N. of 18°. The direction of the doleryte layer shows the prevailing direction of the dip of the rock in general, in which it is imbedded, though otherwise it would be only conjecturally to the northeast. Round the next little point come in alternations of trap and amygdaloid, as before described, dipping with the basalt last described. These continue to an exposure of conglomerate similar to that seen in Baptism river, dipping north at an angle of eight or ten degrees. The exposure of this conglomerate is 30 feet high.

155. Conglomerate. This has calcite nodules, and some laumontite. The stones are occasionally one foot in diameter. The higher beds come down to the beach with a low outcrop toward the west. but to the east the conglomerate is changed gradually into a reddish-brown or nearly black rock wholly metamorphosed and at a distance appearing firm and close-jointed like a fine dyke rock. Were it not for a continuance of the lines of stratification from the real conglomorate into this, it is hardly possible to recognize this as a conglomorate.

155 A. The pebbles are changed and closely cemented in the metamorphic parts, and only appear as blotches of dark brown color. The whole takes more the aspect of a fine but firm breccia like others that have been seen. The cause of this hardening and changing of the conglomerate is a doleryte dyke 20 feet wide, immediately on the east, running a few degrees west of north. This, in connection with another but a few feet distant, seen after passing the little point, seems to have caused a fault, so that the conglomerate is not seen beyond them. A bold short point of rock, like the palisade rock, next comes in, but it seems to be cut off by an immense dyke that runs behind it, and perhaps is the main dyke, the former being branches. This is 75 or 80 feet wide. Then follow successive layers of trap and amygdaloid, with a high dip about north, repeating the phenomena already noted. The dip here is about 40° N. 10° E. This makes a most beautiful nest of pinnacles and purgatories in quick succession, as the basalt beds project into the lake and break down by piecemeal, so as to leave sharp islands and belfries standing with the water on all sides. After this supervenes a heavy bedded coarse trap. crossed soon by a dyke ; and after this a pebbly beach for 40 rods, behind which seems to run the strike of the conglomerate, judging from the fragments on the shore.

156. Then comes a massive heavy rock, with a considerable ingredient of red, with jointed and contorted lamination, or in heavy massive beds. It has much amphibole and much magnetite. In other places it contains orthoclase and laumontite, the latter mineral causing an easy, natural disintegration. This is terminated eastwardly by a doleryte dyke 50 feet wide. It seems to be partly derived from the igneous rocks themselves, mixed in eruption with fused portions of the sedimentaries.

157. On the east of this dyke, where several veins seem to radiate inland, appears a light reddish hard rock, consisting largely of orthoclase and quartz, the former being imperfectly crystalline, with magnetite and red ochre in smaller quantities. This forms a high bluff for 10 rods, and is terminated by another dyke of 35 feet. Two other dykes also cross this red rock. (See No. 636.) Then, after a short pebbly beach, alternating beds of amygdaloid and basalt return, dipping S. W. This is near the western side of the broad shallow bay, on Sec. 30, T. 57, 6, where a hill rises near the shore. This bay is ½ mile or more across, has a pebbly beach except at one small point near its head, where a trap, coarse and rough, makes a small outcrop. The point on the east of this bay

is of trap and amygdaloid, in irregular alternation, rising 25 feet. It is long in the direction of the coast line, and precipitous. (See Nos. 630 and 631). Similar alternations of trap and amygdaloid (Nos. 631, 2, 3, 4, 5), with irregular bedding but nearly constant outcrop, run along for a mile, when the beach becomes stony and low, with occasional exposures of dark, rough and vesicular trap, to Little Marais. (V. No. 158). This is a short sandy and pebbly beach, crossed by the entrance of two little creeks, guarded from the N. E. winds by a hard trap rock layer that runs out in the lake like a breakwater, some distance; but toward the S. and S. W. it is perfectly exposed to the lake.

158. The rock first west of Little Marais; trap and amygdaloid, the latter having saponite and stilbite filling cavities, with some thomsonite.

158. A. Stilbite &c., from No. 158.

159. From the extreme east end of Little Marais bay; amygdaloid that is derived from conglomerate; contains amygdules of stilbite, mainly, but also saponite and calcite; having a general rusty-red color; underlies the next.

160. Forms the point that protects Little Marais from the east, and occupying, in the form of basaltic trap, the coast for two and a half miles further east, rising in some places about 100 feet, the conglomerate sometimes rising 50 feet above the lake, making a bold and dangerous strip of coast for small boats. The two interlock, and blend in stratification, and the conglomeratic characters, particularly, become confused, and even lost, apparently passing into amygdaloid. They dip toward the lake in the main, but there are spots where the dip is invisible. These extend to and beyond the Manitou river (See Nos. 628 and 629). This river makes a perpendicular plunge of about 20 feet just at the shore, but within a re-entrant angle and a narrow gorge. The river on entering the lake passes under an arch of confused and igneous conglomeritic rock; the latter characters being also mingled with amygdaloid, suggesting that perhaps other amygdaloids are changed conglomerates or other sedimentary rocks. This is a beautiful little niche in the coast line, the roar of the falls being as loud as that of the beach, and not more than 50 or 60 feet distant from each other. There is a narrow, crooked gorge also above the falls, but the river is wholly invisible, a sudden jog to the west cutting off all vision above, so that the water seems to come directly from the rock bluff. The lake bluff is about 65 feet high, and perpendicular from

the water. The overlying trap, somewhat basaltic, is about 30 feet thick. [V. 628.]

To the east of Manitou river the bluffs are not so precipitous. but the same rocks continue: and at the next river, where the water in a similar manner makes a short plunge (4 feet), directly from the rock into the lake, the bluffs are about half as high as at Manitou river. This is on the east of Pork Bay, which has a broad, sandy beach.

161. Trap from the shore at the town line betweer ranges 5 and 6 (on sec. 36), one of the layers associated with altered conglomerate in an amygdoloidal state; some having thalite and thomsonite. Some has what appears like prehnite (Lintonite?) and some calcite. These are not easily disseminated, but often are found in patches or clumps closely aggregated, the rest of the rock having less.

161. A. Brown, aluminous vein-rock in No. 161. These veins are from two to four inches wide.

161. B. Pebbles of thomsonite. from the top of No. 161.

162. Amygdoloid from the same place as No. 161.

From the last place to Sugar Loaf Point the coast is low, with much stony and gravelly beach. the points only being of rock: this rock is coarse dark trap.

163. From Sugar Loaf Point; a small point enclosing a little bay and harbor on the northwest side with a sandy beach, and having a conspicuous tuft of trees standing isolated from the low shore lying next west of it. The rock is rough trap consisting of two sorts and dipping south 10° east. at an angle of about 12 degrees. The upper part appears to be somewhat more uniform and basaltic, or massive. and of a greenish color. 18 feet thick. The lower is harder and has many concretions and amygdaloidal spots. These spots are in nests. the amygdules being of thomsonite and stilbite (?). There are perhaps of this 3 or 4 feet, but it is irregularly bedded, and contains pebbles as if conglomeritic. These pebbles and enclosed masses seem to be so thoroughly embraced in the rock that they were more likely to have been in the molten mass--semi-fused—than to have been of marine origin. The greenish color of the upper portion seems to come from the weathering of the firm trap. The upper portion also becomes globuliferous in disintegrating under the weather, exhibiting the characters that have been ascribed to melaphyre.

East of Sugar Loaf Point, to Two Islands, the coast is rocky most of the way, particularly in the western portions, with several short pebbly beaches. The rock is of the same sort as at the point, and along the beach are strewn white pebbles of thomsonite, with stilbite. The coarse basalt of the point rises again immediately on the east of the bay, disclosing purgatories below it in the amygdaloid, the bluff rising 25 feet, and being cut by canyon-like gorges, and crossed by two or three little streams before reaching Two Island river.

164. Trap rock, like No. 163. dipping toward the lake at an angle of about 12 degrees, between Sugar Loaf Point and Two Island river.

165. From the westerly of the Two Islands. The rock rises about 40 feet. basaltiform, on the west side, dipping S. E., conformably with the dip of the rock on the shore. The westerly is the larger island. 40 rods long. the other being about 20 feet high and 20 rods long. The rock is similar to that of No. 163.

The Two Island river, like many others, is closed during the summer months by a gravely spit that turns westerly from its point of starting from the shore, under the action of the wind and waves of the lake as opposed by the current of the river. The drift of the beach seems always to be toward the west, and these spits that shut up the streams are uniformly in that direction, the river being continued sometimes behind the spit for several rods before, by entering the gravel. it is finally lost altogether. The coast line is hardly broken by the river, especially in the existence of this spit, but the valley seems to be in the eroded place of one of the more amygdaloidal layers of the igneous formation that forms the coast line. There are several falls a short distance up this stream, as there are up all these streams, making the north shore more abundant in water-power than any other part of the State.

The rock of Two Island river continues to form the coast to Cross river, the shore ascending from the water with the slightly varying drift, from three to fifteen feet, but rarely having perpendicular walls.

At Temperance river the same beds are cut through by the river, and the underlying amygdaloid allows of the sudden recession of the lowest rock-barrier within the line of coast, so as to form a small rock-bound amphitheater, rising suddenly and perpendicularly from the lake-level on all sides, forming a good harbor for small boats. This is entered through a little niche in the rocky coast, in quiet water. The water of the river descends by a short plunge over the next lower layer of trap-rock directly into the water on a level with Lake Superior. Above the fall is a narrow gorge, only visible on ascending the rocks, crooked and filled with cascades, through which the river rushes with a rapid current, throwing a white spray on all sides. This gorge exhibits some large pot-holes, some also worn and broken, thus showing how the river has eaten into the rock and excavated this gorge. There is no larger stream between this and the St. Louis.

Ascending the Temperance river the layers of the copper series can be seen constantly rising, the dip of the formation being greater than the descent of the river, so that by the time the falls are reached several hundred feet of thickness of beds have been passed over. They all have a general resemblance to themselves, being a trap like Nos. 163, 4, 5, but in places, or rather in beds, amygdaloidal, these beds coming in with a rough alternation, but not with continued regularity. They may have been partly sedimentary, but they show no outward signs of it, except, perhaps, this kind of stratification—which still may be due to successive overflows of lava. Indeed the amygdaloid beds seem to alternate in a manner as if a flow of lava became amygdaloided by degrees toward the upper surface, the denser portions passing upwardly gradually into the more open, but the open parts passing upwardly suddenly to compact, non-vesicular layers. There is also a marking on the uper surfaces of some of the amygdaloidal beds, which seems to show the effect of cooling from a molten condition. These marks or wrinkles are transverse to the direction of the dip. They are in a finer grained rock, though on the upper surface of the amygdaloidal layers, and seem to be of the same kind of rock, though redder, as the amygdaloid itself. They are seen at four different horizons, and overlie uniformly beds of a foot or a foot and a half up to three feet and a half of amygdaloidal trap, with which they are connected by slow changes into the same structure. They are themselves somewhat amygdaloidal, but with much finer and fewer amygdules. There is sometimes a thin belt, or interrupted stratum, of highly and coarsely vesicular and amygdaloidal rock immediately under the wrinkles, which causes the separation of sheets of the wrinkled finer rock from the rest of the bed. These wrinkled surfaces, which are transverse to the supposed flow of the molten rock toward the Lake Superior basin, may have been caused by the superficial cooling of a film of rock on the surface of the flowing lava. The lava continuing to flow—

toward the lake valley—the film was wrinkled by being obstructed by its own stiffness, as cream is wrinkled transversely on the edge of a pan as the milk runs out below. As the liquid below moved on, the crust somewhat stiffened, could not so freely move, but yet was not hard enough to maintain its position. By friction it was carried on more slowly, but wrinkled transverse to the force moving it. The crumpled layers are about an inch thick, but sometimes two or three are infolded upon each other, making a crumpled layer of three or four inches. They are much finer and denser in grain and structure than the beds on which they lie, and are of a redder color. The convex sides of the wrinkles are upward. The trap here is all of a dark color, as distinguished from the red trap and laumontitic amygdaloids, and overlies the red amygdaloids between here and Poplar river. The amygdules are calcite, stilbite, thomsonite, with chlorite in its various stages of change. Sometimes embraced in these wrinkled layers are lenticular areas or patches, ½ inch to 1½ inch thick, of a red grit, resembling the red sandrock with which these traps are associated; and within the amphitheater, near the water on the north side, is an irregular triangular patch of ferruginous, thinbedded shale, itself amygdaloidal, lying under a layer of dark trap and over the beds that show these wrinkled surfaces. Five layers of alternating trap and amygdaloid are visible between the lake and the first fall, somewhat less than ¼ mile up the river.

166. Heavy, dark trap, forming the gate to the amphitheater at Temperance river, from the top of the bluff, 22-25 feet.

167. Ochery, red, shaly beds of grit in a niche in the disturbed amygdaloid under the beds of No. 166, 0 to 3 feet; with fine argillaceous films.

168. Amygdaloid of calcite; same as the next, but taken higher in the beds.

169. Upper surface of an amygdaloid layer, rising like a dome near the water, exposing 3 feet.

170. Wrinkled upper surface of an amygdaloid layer, from near the mouth of the river.

171. From the lowest layer exposed at the falls, about one mile up Temperance river; outwardly a trap undistinguishable from all the rest at Temperance river. This fall is on N. W.¼ sec. 30 where a little creek joins the river from the northwest.

The gorge of this river, and the falls, taken with the cascades, the potholes and the rapid descent, are altogether a most remarkable combination of picturesque river erosion. They are in the midst of inaccessible and wild scenery. The gorge is so narrow it can be stepped across, the only danger being to secure footing on the other side, for a failure would precipitate a man down a gorge from 50 to 100 feet into a foaming river. In one part of this gorge which is about 60 rods long, are several perpindicular falls of the water, some of them being into large potholes, from which the water whirls and plunges downward obliquely into others. Some of the abandoned potholes are on the rock a hundred feet above the water, and some are even outside the river gorge, and show where the river has acted formerly.

172. About ¾ mile below the mouth of Temperance river; from a layer of trap that weathers green, is irregularly bedded and in spots is amygdaloidal. This is a little higher than No. 166, in the bedding, but at points further east, and particularly at a point about ⅓ mile east of Temperance river, seems to hold large globular masses, as if of boulders, and at other places seems to be conglomeritic in the same way. Nos. 167 and 168 become a thinly bedded amygdaloid running along the shore between No. 166 and No. 169.

172. A. Slickensided stilbite, from this.

173. N. E. Cor. Sec. 28, T. 59, 4. In a little stony bay facing N. E. This bay is partly shut in by a projecting trap point running N. E., from which this number is obtained. It is an amygdaloidal trap containing stilbite, thalite, calcite, with some laumontite in amygdules and in nests, and joints. The stilbite occupies the larger cavities, or lines them, the thalite being as filling to amygdules or in geodes of stilbite. The rock itself is roughly bedded, and dips toward the lake at an angle of about 10 degrees.

173 A. Stilbite, taken from No, 173.

173 B. Weathered stilbite (?) from the beach in the bay on Sec. 28, near No. 173.

174. At five miles from Temperance River (Sec. 12, R. 4. T. 59.) the bluffs rise from 20 to 40 feet, and are made up of trap and amygdaloid, sometimes having the globuliferous jointage noted near Temperance River; the amygdaloid also sometimes being conglomeritic, containing harder masses of more compact rock; still somewhat amygdaloidal; and a ferruginous sandstone which seems rather to fill veins and irregular cavities. There is much calcite and laumontite in this amygdaloid. The samples with this number are of the more compact rock in the amygdaloid, and of the sandstone. There are many deep purgatories and arched passages and buttressed porches along here. The globuliferous jointage

noted is not due to the existence of boulders in the mass, but to a natural separation of the bed along conchoidal or curving surfaces, as it prepares to disintegrate. These all dip toward the lake about 15 degrees.

175. At six miles (about) east of Temperance River (the coast all the way from that river being continuously rocky with the same as seen at Temp. R.), the conglomeritic beds appear on the coast. Here they are more distinctly conglomeritic than at other points. Some of them contain angular and somewhat rounded masses of different texture, though not of much different color or composition from the mass of the rock. Here there are also lumps of amygdaloid contained in a red sandrock, the amygdules being largely of calcite and laumontite; but the sandstone, which, however, is hardly gritty, but ferruginous and aluminous, makes up less than one-half of the mass. These beds (No. 175) are about six feet thick. They are overlain, in an oblique upward strike from the water, by a bed of trap undistinguishable from the trap that occurs frequently along here, and are underlain by the next.

176. A tough, thin-bedded rock, containing much iron, and having a red mineral (heulaudite ?) separating its frequent joints, so as to appear blood-red on approach, or spotted blood-red. Its general color is dark-brown or black, and it is seamed with calcite, heulaudite and laumontite, the second including the other two as between the walls of a vein, the veins being rarely more than ½ inch in thickness. It is finely amygdaloidal with the same minerals; 22 feet thick; resembles the Two Harbor rock.

177. Is another bed of amygdaloid and sandstone, eight feet thick, underlying No. 176. (See No. 626).

178. Shows four feet, but beyond at another bluff, rises so as to show ten feet. It is a less amygdaloidal state of No. 177, and lies below No. 177. The last two numbers are got about fifty rods east of Nos. 175 and 176. There is an isolated pillar of No. 176 standing on a broad pedestal rising about twelve feet high, about forty feet from the shore.

Round the next little point, about 20 rods further, these beds are broken and confused, the dip changing to the southwest. There are here broken upward bends, or domes, of soft amygdaloid that encroach on No. 176 so as by weathering to make deep purgatories with buttresses of No. 176 separating them. After a short interval the beds go back again, and retain their usual dip toward the lake. (Compare No. 626).

179. Comes in below these amaygdaloids, at about a mile west of Poplar river; a greenish heavily bedded doleryte; rising about 10 feet and returning near the water, as the coast line crosses the strike of the beds. The coast between Temperance and Poplar rivers is very picturesque and interesting, but difficult for small boats. The trap and amygdaloids take a thousand fantastic shapes, as the line of the lake level cuts across the undulations of their bedding and change of dip. Sometimes the bridge of trap, as it runs down to the lake, is entirely eaten under, forming deep purgatories; or it sometimes breaks down, leaving islands of rock just off the line of coast. Sometimes island, bridge, and all are taken away, and the waves break on the base of a high bluff that often rises perpendicularly from the water, or is skirted by a little short pebbly beach, a rod or more inside the line of islands.

180. From the middle island at the mouth of Poplar river. Here the strike of a heavy layer of trap runs along the shore; but about six rods lakeward it exists as islands and a reef left by the waves, thus enclosing a small and imperfect harbor for small boats; contains thomsonite.

181. Underlies No. 180 and does not vary much from it, except in being more evenly and more thinly bedded; and in separating into closer joints, so as to disintegrate, leaving No. 180 to stand alone, and really causing its more rapid demolition. Nos. 180 and 181 form substantially one rock, and are both what has been styled trap along here. In weathering they become very rusty, when not under friction, and brick-red, crumbling in little red globules. These beds are 24 ft. thick.

182. Is directly under No. 181, and is a shaly, red, easily crumbling rock, apparently of not uniform thickness, but in one place, is about 8 ft. thick: on the east of Poplar river associated with a red conglomerate.

183. A highly amygddaloidal rock, exposed below No. 182, but ascending, at other places when exposed, so as to "pinch" out No. 182, and almost uniting with No. 181. This crumbles and gets brick-red on weathering on the beach. Nos. 182 and 183 seem to be the equivalents of Nos. 175, 176 and 177, but there is here no layer like No. 176.

184. A vein of breccia (?) about 18 or 20 inches wide crosses the face of a crumbling, greenish trap, running N. 40° E.; similar to a rock that seems to have been embraced in the vein; ½ mile east of Poplar river. This vein is nearly white and is made up of calcite, thomsonite and laumontite.

185. Laumontite and silbite; each associated with calcite, occur in large nests in the rock, of about the same beds as 183, at 3 miles east of Poplar river.

186. A little further east can be seen a very interesting instance of the manner of weathering of the trap beds. This is similar to what has been mentioned before. and styled globuliferous. The rock seems to decay to a considerable depth, and to assume a globular structure, the little globules being rough exteriorly, and generally about ½ inch across. This cannot be due wholly to any peculiarity of circumstance in exposure, since here we have an opportunity to see alternations of rough and globular weathering and of smooth weathering alternating in beds one above the other, the beds being otherwise outwardly undistinguishable. The rough and globular layers show these characters both near the water and also as they rise obliquely across the bluff, and the same is true of the smooth weathering layers. Samples show both.

187. An amygdaloid containing amygdules of zeolitic minerals, as stilbite and thomsonite, as well as delessite. Some of the crystalline nests are large, the thomsonite appearing agatelike. Some of the thomsonite is of the variety lintonite. This is at Eclipse Branch. [V. 625].

188. A greenish dolertye that weathers softer, slippery and smooth. It occurs suddenly at first, on a point running N. E. (Eclipse Beach), and enclosing a little bay, being a bed of overflow of igneous rock. It embraces corrugated surfaces like those seen at Temperance river. especially at points a little further east where it becomes closely associated with No. 187, which it overlies. It seems to embrace parts of No. 187, and then to take its place. The corrugated areas are small, the wrinkles curving, and being in various directions, sometimes like an inverted basin. (The equivalent to No. 623).

With various unimportant alterations between 187 and 188, or rock undistinguishable from them. but with a dip toward the lake of 8° to 15°, the coast continues rocky from the last point to Cariboo Point, (sometimes styled Black Point), and generally low, with only occasionally a bluff rising 10 or 15 feet. At Spruce river a high bluff rises along the right bank near the mouth.

189. Cariboo Point, S. W¼ Sec. 11, T. 60. R. 2. The rock of the point is represented by this number, and is of the same horizon as No. 188. On the east side of the point this rock is basaltic radiatingly, and shows a thickness of 8 to 12 feet. The basaltic columns gradually give way to a bedded stricture toward the

north. In some places it is fine-textured, especially near the top, and there shows the corrugations of surface that has been supposed to be old lava-crusts; but generally these are smoother than those seen at Temperance river. This dips toward the lake at an angle of about 10° and lies on the next.

190. A brownish-red sandstone, or shale, so fragile as to fall to pieces by handling; within the bay inclosed by Cariboo Point. This has a cross-lamination, and toward its junction with No. 189 is much less siliceous, and more aluminous for a thickness of about 12 feet. Its dip causes it to disappear, and its fragile character to become covered, within four rods of its first appearance, under No. 189. It re-appears slightly about 15 rods within the bay, having the same dip. Then for a little more than ¼ mile the coast is low and only pebbly. Beyond that, however, the shore shows the same rock again as on the west of Cariboo Point, though at first appearing more brecciated or conglomeritic. This sandstone layer) No. 190), is doubtless the same, or very nearly on the same horizon as some of the laumontitic amygdaloids so frequently seen further west, the conditions of metamorphism at this place not having been such as to convert it to amygdaloid. It is plain that not much heat accompanied the overflow of No. 189, as it seems not to have affected No. 190, the transition being abrupt from one to the other. (See after No. 293).

191. The rock which first appears on the east of Cariboo bay continues to Cascade river, forming a line of low coast. This number represents it at Cascade river. It there overlies the next.

192. A reddish-brown amygdaloidal, finer-grained rock than No. 191 ; forms a low outcrop on the right bank, near the mouth.

Trap-rock, like No. 191, occupies the coast, without any intermixture of amygdaloid, forming a low, dark, coast-line, to the point half way between Cascade river and the point on the west of Good Harbor Bay. At this midway point No. 191 is broken into, allowing the formation of a deep bay (Lover's Bay), while its direction near the lake level can be seen in a small island east of the point. Under No. 191, within this bay, are beds of less firm rocks which by the erosion of the lake cause the destruction of the overlaying beds, which, as the dip rises, make the top of the bluff at the head of the bay, rising 50 or 60 feet. This bed is greenish-black and contains thomsonite; sometimes basaltic and sometimes bedded, with a few spots of enclosed reddish amygdaloid. In other places the doleryte itself more compact and of a reddish-brown color in patches, as if brecciated or irregularly cooled, shows lava-crusts and included angular and rounded masses. In these places the surfaces are firm, rough, and many-jointed. In other parts the dark green color returns, and the rock weathers smooth under friction, but in the weather only it crumbles. A lower bed of amygdaloidal trap, with purgatories, generally low, but rising near Terrace Point to 18 or 25 feet in height, extends from Lover's Bay to Good Harbor Bay. Near Terrace Point it presents much the character and confused composition as seen at Lover's Bay, being reddish-brown and brecciated, the top being more dark and firm, like a true doleryte, and containing thomsonite.

193. This is from the very point, which sharply encloses Good Harbor Bay; a green-weathering doleryte, containing thomsonite. (V. No. 535.) This dips conspicuously, and overlies a brown sandstone, or shale, which also dips toward the lake and runs 14 hundred feet along the shore.

194. Brown sandstone, from Good Harbor Bay; aluminous; by making measurement along the beach the outcrop is found to extend 1400 feet, with an average dip of 8½ degrees toward the lake; by trigonometrical calculation the thickness of the strata is ascertained to be 206.9 feet, as exposed, but the thickness must be considerably more, owing to the non-exposure of rock in an interval of nearly 1000 feet before the underlying firm beds appear in the beach further north. This is probably the equivalent of the sandrock at Cariboo Point, but may be another stratum. It is very frail and although sometimes a little slaty it will easily fall to pieces if taken in the hand.

195. Is a firm but porous amygdaloid, the pores and seams sometimes being quartz-filled, and iron coated. From the north side of the first little creek in Good Harbor Bay, underlying No. 194, but not immediately. Very soon the shore becomes rocky with a brown, rough rock, irregularly jointed and compact, appearing like that at Two Harbor Bay. This soon becomes irregularly mixed with the usual doleryte which extends to the second little creek, where there is a short pebbly beach. The same rocks soon return. The shore is rocky nearly all the way then to the point that encloses the bay in which Fall river empties.

196. From the rocky island off the point that encloses Good Harbor bay; a doleryte containing stilbite; similar to, and in the line of bearing of No. 193.

197. A reddish brown rock, closely jointed, and also breaking sharply with a conchoidal fracture; very rough exteriorly, i. e. with sharp projecting angles that tear the boots, but not porous or open; forms the point and coast line first east of Good Harbor bay, east of No. 195.

198. After passing a little point and a bay facing east, a green-weathering rock, finely jointed, and having an interior brown color, appears along the shore, and finally shows a basaltic structure and coarser grain near Fall river, where it stands out in the beach, and was illustrated in Norwood's report. Samples are from the basaltic parts. At some places the rock along here, west of Fall river, is slaty, and has a green color. Rock No. 198 extends to Grand Marais, generally showing its basaltic columns; but along the beach at one point having an amygdaloidal red rock below it.

199. The same as No. 198; from the basalt at Grand Marais, Contains plagioclase, diallage, magnetite, hæmatite, ferrite, apatite.

200. Samples of copper-bearing green-stone (gabbro), from N. W. ¼, Sec. 24, T. 61, R. 1 W., up Fall river. This heavy-bedded rock has slickensided seams, or thin filling between layers. These seams contain much chloritic mineral (delessite ?), some layers of it being ½ inch thick, with stilbite closely mixed with it, and also small quantities of calcite; the copper occurring in the massive, hard greenstone, or doleryte, in the form of thin spangling sheets once or twice the thickness of paper, or even ¼ inch thick. The sheets sometimes embrace three or four square inches in area. This location was wrought by Johnson & Maguire in the summer of 1876, and the face of the rock shows perpendicularly about 18 feet. It probably exists as a dyke.

200 A. Concretionary masses within No. 200, apparently having a large amount of diallage (?) with olivine, orthoclase and a white radiated zeolite, like prelinite. These concretions are perhaps produced by the inclusion of fragments of No. 201 in No. 200, when the latter was in a fluid state.

201. This, which is cut by No. 200, is the palisade rock, but has fewer of the translucent crystals of adularia than the Palisades themselves. It is properly styled a porphyritic, orthoclastic felsite. It is from the mine on Fall river.

202. Green, coarse doleryte, round the east point of Grand Marais; a low exposure in the coast line; with concretions or inclusions of a finer grain. This terminates rather abruptly on the

east, somewhat like a dyke when in contact with No. 203; but it is not basaltic, nor is the contact abrupt. Number 202 and 203 change colors gradually, and in fragments are mixed through a breccia of three or four feet wide.

203. Resembles No. 201, and is much like the Palisade rock. It furnishes pebbles for the beach which are strewn all along, making the beaches at Grand Marais. Dips 5 to 15 degrees toward the lake, or by the coincidence of the coast line it appears sometimes nearly horizontal. Sometimes it resembles the siliceous gray slates of Beaver Bay, No. 127. (v. 528). Under the microscope in a thin section this rock proves to be an orthoclastic red felsite. There are mono-clinic crystals of orthoclase in a translucent material, as well as sometimes large areas of orthoclase which show a uniform clearage and direction, as if belonging to one crystal in the general felsitic mass; but in general the felsitic mass is clouded simply by ferrite, and not distinctly crystallized; or in the thinner portions of the section it is porphyritic with sections of fine tabular crystals. These very generally darken when about parallel with either spider line, but not always.

203. A. From a vein of laumontite in No. 203.

204. }
205. } Transition rocks in the order numbered, between Nos. 202 and 203.
206. }

207. A doleryte like No. 202 which suddenly comes in crossing the beds of No. 203, forming a little point in the coast. This dyke is about 200 feet wide, and gives place to the beds of 203 again on the east.

These run perhaps 500 feet when another similar dyke crosses them. There are six such within a mile along here, and some are basaltiform obliquely. They run E. 15° S.

208. This rock occurs much like a dyke at first with perpendicular jointage, or basaltic structure in beds, but soon larger bedding crossing these, cut it, and cause the rock to all appear bedded. This is fine-grained and brown, and is about 25 rods from the last of the dykes already mentioned. This becomes a bedded rock, like similar beds seen before, having sometimes the appearance of the Two Harbor rock. It slopes toward the water. Just beyond the mouth of the third little creek (on the Lake Survey Chart) these beds become disturbed and brecciated and even tipped in the other direction (S. W.) and are crossed by a dyke of doleryte like No. 207, about 18 feet wide. Previous to this (further west) they show patches amygdaloidal; but just on the east of this dyke

there is much amygdaloid with laumontite. Just before reaching the mouth of the fourth creek another dyke like 207 crosses these beds running in the same direction as those before seen, and throwing up the firm heavy beds of No. 208 at a high angle. This dyke is basaltic perpendicular to these beds by being cooled by them. This last larger dyke is only exposed near the water, and its exact contact with No. 208 is invisible. It is exposed about fifty feet.

209. This is from still another similar dyke of doleryte cutting these beds, or interbedded in them : the columns sloping obliquely inland. This is prominent and conspiciously basaltic perpendicularly to the highly tilted beds of No. 208. This dyke or bedded trap rock runs nearly E. and W., No. 208 dipping into the lake at an angle of about 45° in patches perhaps 20 rods, becoming less conspicuous toward the east, and at last disappears a few rods west of the mouth of the Devil's Track river under a low, red, pebbly beach, the pebbles being from No. 203, which here appears again. This beach continues for a mile or more, occasionally allowing the exposure of the rock in place, to the S. E. corner of Sec. 8, T. 61, R. 2, E., where appears in the midst of the shingle of the beach a different rock, viz:

210. This is in a low exposure. It is a firm, smooth-weathering rock, with a brown color and has an abundant green mineral; apparently one of the igneous beds.

211. Is from the same beds as No. 210, but from the point next west of Kimball's creek, known as Cow's Tongue Point. These beds here rise about 18 feet, shutting in a bay that faces east. This point is on S. E. ¼, Sec. 9, and the coast is rocky, with the same rock from No. 210 to this place.

212. After a short red-pebbly beach, in this bay, this number appears in low outcrop, and is the same redrock as No. 203, showing here nearly a horizontal bedding, running below No. 211.

.213. From the extremity of Fish-hook Point, near the center of Sec. 16, T. 61, R. 3 E., eleven miles from Grand Marais.

314. Similar to No. 213. From Sec. 1, T. 61, R. 2 E., at the mouth of a little creek, west of No. 213.

315. Half a mile west of Fish-hook Point. These three numbers (213, 214, 215) all appear to be modified forms of No. 203. Fish-hook Point was formerly an island, but the lake has formed a continuous beach deposit running north, and enclosing triangularly a lagoon, as well as toward the S. W. The rock here resembles the rock No. 212 in mineral composition and aspect, and is probably closely associated with it, but its structure is different.

It is fissile, but generally only horizontally so, or with an obliqueness to the real bedding, which dips gently toward the lake. It is firm against the hammer and against the weather, but is filled with old cracks and joints that make it almost impossible to get a fresh break. It has a red color outwardly, like the rest near the water, except in the joints, which are blue-black with iron-shot (as Norwood describes such); but away from constant wave-action it is black. It is finely porphyritic, with stellar spangles of feldspar, and with isolated crystals which weather nearly white.

214. Is of similar rock, but more firm and crystalline, weathering red, and having some white amygdules. This has a low, inconspicuous outcrop, like others of No. 203, running along two or three hundred feet and dipping a little south of east. Number 215 is from a little point within the broad bay, nearly on the west side of the same section, where it rises about 6 feet, and, running along the beach three or four hundred feet, weathers red, like the rest, furnishing some of the beach pebbles of that color, In the lake opposite Nos. 214 and 215 can be seen a basaltic rock off shore, which does not appear on the beach and may be the extension of Nos. 210 and 211 forming Cow's Tongue Point.

216. Is a greenish-brown rock with curling internal structure, containing quartz and amethystine nests, from the westerly of the two little points west of Brule river, and before reaching either island, where a little stream enters the lake. It is a short outcrop rising about 5 feet in the midst of a red beach. This is an igneous rock; and the next point is of the same, also the little island off it, which is in the line of bearing.

217. In the midst of a red beach, extending from the last point, is an occasional exposure of this red rock, which within is brownish-red, fine-grained, and has the same purplish quartz (?), as noted in No. 216, in round amygdules, yet is plainly different from No. 216. It belongs to the modified sedimentaries of the kind like the Good Harbor rock. This is a conspicuous outcrop within the bay between two streams. The strike of the trap (No. 216), can be seen under the water of the bay

218. The rock of the point, near the Brule river, off which lie the principal islands. This is a brown, conchidally fracturing rock, fine-grained or crypto-crystalline, with small quartz-lined geodes, weathering rough-angular, and black when not under friction. Back from the line of friction, on the beach, old weathered surfaces are brick-red. This is very similar to No. 217.

219. A little beyond the last locality, and just as the rock dis-

appears again, it suddenly becomes slaty or closely-jointed and laminated, dipping S. 10° E., and more enduring. In this condition it forms some of the islands near the beach, and also rises 50 or more feet near the coast back from the water. This is fine-grained and nearly black, hard and tough. The rock of the main island, further out, containing a few stunted trees, is more like No. 218.

These beds seem to have been disturbed by some upheaval, and appear in all respects like those of No. 208, though not so conspicuously exposed. The doleryte dyke that might here be supposed on the north of this disturbance cannot be seen. The point at the north of the little stream west of the Brule, and the little island there, are of the same rock as the last.

220. Between these islands and the mouth of the Brule at a little dull point is a bluish-gray rock, weathering green, fine-grained and hard. The outcrop is rather closely jointed and in some spots it is reddish brown. This rises about 6 feet, but only runs 5 or 6 rods. The beach to the west of this is mainly of a red color, but has blue pebbles also from this rock. At this place the blue and red are about equally common, but the red gradually disappear in going east. (V. 539).

221. A short distance east of the Brule (perhaps 20 rods) is a coarser rock resembling gabbro, which is heavy and crystalline. This is not certainly a dyke, but it may be, its form and extent not being visible. This rock makes a fine thin-section, showing coarse crystals of plagioclase and diallage, with magnetite. The diallage frequently shows a fine striation of four or five belts, crossing the body of a grain, generally near the center, having color like striated feldspar. But these striæ are always in a single group. The halves of the grain have certainly different axes of elasticity, darkening at different places; hence it appears twined like plagioclase. Similar striation appears in other samples of rock containing diallage, and might be attributed to a grain of plagioclase lying under and showing through.

222. The last seems to overlie, or to pass into this. This weathers into a green color, but sparkles all over with what at first appears like mica, but in other respects it is like the last, becoming coarsely laminated when weathered. A little further east these two rocks (221 and 222) can be seen in a bluff rising about 15 feet, the latter being under the former. This rock continues, with increase of the characters of No. 221, and forms two or three little points within a mile east of the Brule, rising sometimes 15 or 25

feet. The intervening bays are occupied by large rounded boulders of the same, with little rock exposure in them, or they are pebbly.

223. The rock of the last continues to the high, round point 4 miles east of the Brule, and then becomes basaltic on the side facing Sickle Bay, rising about 30 feet perpendicular from the water; the intervening coast being low, sometimes exhibiting the coarse dark beds of this rock, but not becoming basaltic. (V. No. 540).

224. Horseshoe Bay has a similar basaltic coast line on the west side, rising about 60 feet. West of it are short stony beaches, the strike of the exposed rock being a little further back. Double Bay, next east of Horseshoe Bay, has a rocky point, dividing it into two parts, and this rock is from this point. The western half of this bay is without rock on the beach, but the hills back rise several hundred feet, having the same rock as the last. This is a fine-grained, metamorphic, brown rock, which is somewhat basaltic like trap, and also rudely bedded.

225. On the most easterly point of Double Bay is a crystalline rock which seems to embrace the minerals derived from the sedimentaries mingled with igneous rock material, all coarsely crystalline. (V. No. 5).

226. Is from an isolated dyke-like exposure on the beach in the next shallow bay. It is a brown or reddish-brown compact rock, firmly prophyritic, closely jointed and basaltic, like No. 203.

227. Along the west side of the ridge, or spur (No. 226), is a narrow bed or dyke of fine, blue-grey rock, sparingly porphyritic with red feldspar, less enduring than the rock of No. 226. It is nearly invisible, It is narrow, and its line of bearing becomes confused, or blends with the rock of No. 226, being perhaps a modified form only of No. 226, due to different influence in upheaval, or to unseen contact with the accompanying igneous rock. This outcrop is between the 1st and 2d creeks in this broad bay.

On the little point between the 2d and 3d creeks is a low exposure of rock that resembles No. 223, mainly broken into boulders. Also a small isolated outcrop is just east of the 3d creek, otherwise this bay has a pebbly beach. But the broad point that separates it from Cannon Ball Bay, (similar to Horseshoe Bay) has a low, rocky beach of the same rock as the last mentioned, viz:

228. A heavy bedded coarse-grained doleryte. (V. No. 540). The east side of this bay is made of the same rock, also the east point, also the island east of it; the coast being rocky and low, or

rising from six to ten feet, basaltic. The next island, and the coast along, especially the points of the coast, are of the same. It rises into basaltic coarse beds in a sharp point on the west side of Red-rock Bay, succeeded suddenly by a red pebbly beach within the bay, strongly contrasting with the dark green or black color which it suddenly replaces, (230).

229. Doleryte like 228; from Red-rock Bay, west of the red rock, outcropping in the midst of a red pebbly beach; runs under the E. Palisades.

230. Red rock from Red-rock Bay. This resembles, or is exactly the same as the Palisade rock. It is porphyritic with flesh-red feldspar. and with translucent crystals that at a glance appear like quartz, but are seen to be quadrangular in section, sometimes square. and to have a perfect cleavage. The manner of exposure is considerably like that of No. 226 in a little bay west of this place. This rock has an imperfectly and finely basaltic structure, the joints being 2-4 inches apart. The relations of the doleryte to this cannot be distinctly seen. but that rock can be seen to the west in the beach. and probably passes below this. This is the rock known as the eastern Palisades. (V. No. 620).

231. From a dyke of basaltic doleryte a short distance east of the mouth of the Redrock creek. This dyke runs E. and W., and is horizontally columnar. It cuts the rock of No. 230, and varies from 50 to 60 feet wide. It is a fine-grained, blue-black, and weathers greenish. It embraces patches of the red rock.

At Red Point, which encloses a deep little bay facing east, and which is high and rocky, with No. 230, another dyke of the same kind as No. 231 crosses No. 230. It is about 25 feet wide. No. 230 dips into the lake here at an angle of 6 to 10 degrees. It is suddenly discontinued in the bite of this bay, the bluff running inland about 20 feet high, the beach being of red pebbles. Just east of this bay are two or three other dykes of the same kind, and several islands formed by them. also some sharp, narrow points.

232. The first rock that appears in the pebbly beach east of the rock of Red Point, near a dyke: a brownish-red metamorphic compact rock. sometimes with amygdules of a white mineral, coated with green; apparently underlies No. 230; resembles some of the compact brown rocks seen at Duluth and at many intermediate points.

233. From a dyke. near No. 232, 21 feet wide, horizontally columnar, running N. 15° E. and projecting into the bay 75 to 90 feet. of a blue-black color.

234. From a dyke 18 feet wide running E. and W. "hading" a little to the south, cross-columnar, cotemporary and blending with the dyke 233, the structure of the two running together; of a brownish-black color. This rock is like a melaphyre, but No. 233 is not.

235. A rock similar to No. 232, cut by the dykes, having a slaty structure without any dykes; forms the beach next north of the dyke No. 234 which is out in the water.

236. From a dyke 21 feet wide; a fine-grained, black basalt, running out into the lake about 250 feet, but often in the form of islands that occur a little out of line. The basaltic structure of this is very irregular. In some places it is fine and in others it is coarse; runs No. 15° W., being intersected by the dyke No. 234, apparently in the same manner as No. 233.

237. Is from a curious isolated mound of metamorphic firm rock, standing between the beach and the lake, a short distance east of the dyke No. 236. It is curvingly bedded and laminated; rises 18 feet and extends 18 feet on the beach, shaped like a haystack. It has a reddish-brown color. Its manner of occurrence is like that of the rock No. 226.

238. Is from a curving, slaty condition of the same rock, rising 10 feet; there is much confusion and twisting of the slaty sedimentary beds, the whole formation being broken up. Nos. 237 and 238 continue east about half a mile, and gradually become more dense, or non-slaty, yet fissile hard, and angular, crossed by several smaller dykes running E. and W., or S. E. and N. W.

239. Shows the condition of the same beds in process of this change. Here also are slaty spots, also compact firm spots, but instead of red the general color is brown, weathering faint-red in the old joints when freshly separated.

240. A reddish-brown, fine-grained rock, breaking conchoidally, but a further metamorphic condition of No. 235.

241. Still further changed, becoming black, and almost undistinguishable from fine basalt.

242. Next appears a dyke about 100 feet wide, cutting these beds, running nearly E. and W. This seems to have spread largely, at least in its effects, on either side, and the adjoining rock appears like basalt, but still seems to be only a changed condition of No. 235.

Nos. 232 and 235 and their modifications, run under No. 230. There are spots in No. 235 that appear like the aluminous mud-spots seen in No. 194.

The alternating phases of Nos. 239, 240 and 241 continue, with occasional dykes, or overflows of rock like No. 242 to Deronda Bay, appearing like the Two Harbor rock.

243. From the west point of Deronda Bay: a fine-grained, hard, nearly black homogeneous rock, of doubtful origin; probably one of the forms of the rock 235, &c. It is rather bedded, but not basaltic, and lies on an amygdaloid, viz:

244. A reddish-brown amygdaloid, with green amygdules irregularly passing into

245. Which is of the same color but has nests of a lighter mineral, and is mainly a non-amygdaloidal rock. Just west of the west point of Deronda Bay is an island of basalt, near the shore, mainly made up of rock like No. 242, in an arched position, the waves having eaten under the arch into the softer beds producing a natural bridge. The head of Deronda Bay has a pebbly beach, but the east side is rocky, with a dyke that "hades" to the south and is thirty feet wide, running nearly east and west, and cutting rock like 244 and 245 (or 246 and 247). there weathering out as purgatories, and lying nearly horizontal.

246. About ¾ mile east of Deronda Bay at the mouth of another little creek is a bluff of rock made up of Nos. 246 and 247, but running but a short distance. Number 246 is soft and green with considerable procholorite. (?) The lower ten feet of this are somewhat amygdaloidal with calcite and quartz, coated with green, but the upper ten feet are massive or heavily bedded, but breaking easily into sheets; overlies the next.

247. Amygdaloid; rock like the last but having a more amygdaloidal character.

246. A. Calcite, saccharoidal and flesh-colored from 246. These beds dip S. about 12 degrees. East of Deronda Bay the second little sharp point is caused by rock like No. 246 dipping S. rising 10 feet. The third little point, which occurs after a pebbly beach of half a mile, is produced by a wide doleryte dyke running E. 10° S.

248. Is from this dyke, which has an indefinite width, at least 200 feet. This rock is porphyritic, hard and massive. On the north side its contact is a fine basalt, and the adjoining rock is an amygdaloid, but only about six feet of the amygdaloid is here. It lies along the dyke as if it belonged to it.

249. Amygdaloid adjoining No. 248.

250. The west point enclosing Grand Portage Bay is low, but

has a rocky beach consisting of alternate layers of basalt and amygdaloid rising but little above the water.

251. Underlying No. 250; an amygdaloid of a greenish color. These beds (Nos. 250 and 251) dip south at a low angle and do not extend into the bay. They apparently form the coast line between Grand Portage Bay and Deronda Bay, there being but little outcrop with a low shore between these places. The west side of Grand Portage Bay shows no rock. It is low, the timber growing nearly down to the water.

252. Slate from the west side of the village of Grand Portage. The outcrop is near the water and along the beach, rising also into hills a short distance inland. It is cut by a prominent dyke of dolerytе, 39 feet wide, running E. 15° S. Some of it seems to be suitable for roofing, but some is too hard and brittle. It also has septaria several feet wide, round which the slates are disturbed and warped. They dip S. 5 degrees. They are not due to a superinduced slaty clearage, but are caused by the slatiness of the sedimentation with which they are coincident.

253. From the dyke above mentioned, cutting the slates. The high range of hills that culminate in Mt. Josephine, back of Grand Portage, seem, from the lake, to rise from the point west of the E. Palisades, where the rock (540) strikes inland. Their outline and general character resemble the range back of Double bay, further west.

254. Is a quartzose conglomerate, firm and hard, with fragments of slate and quartz pebbles, from the N. W. side of Portage Bay Island. This lies in large fallen pieces on the shore, the island rising perhaps 80 feet. These masses are finely stratified, and even show false bedding; a few rods beyond these fallen pieces, (E.) this conglomerate is in place, dipping S. 10° E., at an angle of 8 or 10 degrees. It shows at least 20 feet, and is cut by a dyke nine feet wide, which is apparently connected with the trap (?), No. 255, that there lies on the conglomerate, and which may have come from overflow from this dyke.

255. This overflow comes down to the water at once and hides the conglomerate, and rises perpendicular about 12 feet. It weathers very rough and open-angular, from containing fragments, apparently, of rock from contiguous formations, that were not wholly molten.

256. Sandstone; of even grain and bedding, lying between layers of trap-rock immediately over No. 255.

257. Gray, thinly-bedded, hard, quartzyte, styled *siliceo-argil-*

laceous shale, by Norwood; at a short distance having the aspect of a bedded slate, probably belonging to the slate formation of No. 252; from the west side of Hat Point, near the extremity, overlain by the next. On the east side of the point can be seen numerous dykes cutting this rock, which probably has a thickness of 500 feet.

258. Basaltic trap-rock, overlying No. 257, and rising at least 150 feet; finally culminating in the summit of Mt. Josephine further north.

259. From layers underlying No. 258, on the east side of Hat Point; lower in the strata than No. 257, but conformable with them apparently, and forming a part of the same terrane; a gray quartzyte, or hardened sandstone, with rounded, apparently concretionary spots (¼ to ½ inch in diameter), of a reddish color; darkened by organic matter (?). Compare No. 270.

260. Near the head of Wauswaugoning Bay a dyke runs S. 45° W., and forms, for a short distance, the shore-line, containing a calcite vein in the center, about 4 inches wide. This is about 20 inches wide, but it so affects the rock which it cuts that it also becomes closely jointed, and almost columnar. The width of the dyke cannot be certainly determined, as another large ridge coming from the N. E., at an angle near oblique to the coast unites with it at its western end. Near this point another calcite vein, five to eight inches wide, crosses the former in a direction nearly E. and W. Embraced in the calcite are small lumps, and almost perfect rhombohedrons of hæmatite. Samples are from the dyke running S. 45° W. The rock (No. 257) cut by this dyke dips S. at an angle of about 15 degrees, and is rather more like a quartzyte than in some other places. A patch of this is included between these dykes that intersect each other, forming a triangle. The long side of the triangle is formed by a dyke running along the shore, rising from two to eighteen feet, but continuing further east for at least ¼ mile, horizontally columnar. The other sides are made by N. E. and N. W. dykes that unite a short distance inland. The first shifts its course a little east of a short pebbly beach, and also sends off an oblique spur which runs nearly south into the bay. In connection with this the slate also reappears, dipping about into the bay—though slate is hardly the word to apply to this rock. It is in some of its layers a pinkish quartzyte, but the greater part is black, or gray-black, sometimes with a shade of blue. It is more aluminous in its dark parts, and is fissile also, but its fissile parts are so strongly protected by the firm and

quartzose beds, which are closely jointed, and often with beautiful symmetry, that they do not weather out much more easily than the rest. Sometimes a layer, however, separates from that below it, over a space of a few square feet, and the argillaceous parts thus exposed become finely, conchoidally jointed, and might be styled botryoidal, like some decaying shale beds.

261. The hill on the N. E. ¼ Sec. 25, T. 64, R. 7, E, rises by aneroid 520 feet above the lake. The Mt. Josephine ridge rises much higher, sweeping, in one of its spurs, toward the northeast past the head of the Wauswaugoning Bay to this point. It is at the summit made of the rock of this number, which is a doleryte like No. 260, of a slightly greenish tint. This fairly represents the rock of all these hills to Grand Portage.

262. Below No. 161 can be seen slaty red quartzyte beds with slate, in the southern slope of the hill, dipping toward the north, or into the hill, at a low angle. The hill is largely made up of this kind of rock. Another smaller dyke, running E. & W. rises into a low hill on the south side of the main hill, and cuts the same quartzyte, which here is more nearly horizontal, yet dips some in the same direction.

263. Is from an overflow of igneous rock, rising irregularly, basaltic perpendicularly, that forms the straight high coast that makes a sharp angle in Wauswaugoning Bay. It is a magnetited doleryte. While it is basaltic on the N. W. side, it is bedded and dips to the S. E. in following it toward Birch Island. This is on N. E. ¼ Sec. 30, T. 64, R. 6 E. It finally becomes overlain by layers of quartzyte—which layers are curved and twisted as if by heat from below. They could not have been deposited as a sediment on No. 263 when the latter was cold, but must have been previously deposited and then disturbed by an injection of the molton rock under them. Angular pieces of the quartzyte are enclosed in No. 263, changing the weathering color and the composition in spots, reminding one of the "red rock" embraced in the "Rice Point Granite" at Duluth.

264. These samples show this enclosure of quartzyte, and also changed quartzyte; from the coast due N. (by compass) from Birch Island. In some spots are specks resembling graphite, with a few specks of pyrite.

265. Is from the upper part of No. 263, where in contact with the quartzyte. The quartzyte is slaty. No. 265 is geodic with fine crystals of quartz (?) surrounded by graphite or mingled with

it, (some of this soft mineral is light-colored, with reflecting surfaces, like talc).

Birch Island is caused by four hardened belts in the quartzyte and slates, from 5 to 10 feet wide, which run E. and W. making the slates darker and in spots basaltic, and yet showing in other spots their bedded slatiness. These belts resemble dykes of igneous rock; and they run as a reef almost to the shore northwardly. The point east of Birch Island is mainly made of red quartzyte, which rises here about 35 feet above the lake, but yet dips south into the lake at an angle of about 8 degrees. It breaks off in steps, back from the shore, from ten to fifteen feet high, and some of it rapidly breaks up into blocks of a few inches. This is especially the case where the hardened belts (or dykes?) from Birch Island cross the point.

265. B. Samples of this quartzyte, showing also glaciation (?) in curving fractures over the surface, like that described on the Rock county quartzyte. But these curves present their concavities toward the S. W. and their convexities N. E., requiring, under the theory of their glaciation applied to Rock county, a movement of ice toward the N. E. These curved fractures have penetrated several inches—some of the larger ones—though this may be due to the continuation of the checks begun by glaciation, by weathering and frost since the glacial epoch. The formation is in most respects very similar to the Rock county quartzyte. But in some places it is conspicuously basaltic, and often contains crystalline grains resembling flesh-red feldspar, as well as darker grains.

275. A. Samples from the darker and firmer parts (as at Birch Island), that appear like dykes.

The coast line for a mile east of Birch Island is formed by the same quartzyte, crossed by several dykes. They cut the quartzyte, running E. and W. or very nearly so. One which is about 25 feet wide has a narrow calcite center, 2-4 inches, and some pyrite. This sometimes becomes two or three veins.

266. From a dyke-rock containing scattered pyrite.

267. Basaltic rock from the main vein, containing a calcite center, and which is about 25 feet wide.

267. A. Calcite and ore from No. 267.

268. Blackened quartzyte, with red (hæmatitic) specks; from near the dyke No. 267. This is of a dark color, but represents the prevailing color.

269. From Island No. 2, being the easterly of the first two islands near the coast; a porphyritic doleryte, the larger crystals be-

ing of a triclinic feldspar. The whole rock is gray, and has small grains of pyrite. The whole island is formed by a dyke of No. 269, flanked by a little quartzyte and slate near the water. The dyke is about 50 feet wide, and the island is not much more.

270. Graphitic rock; Pigeon Point, S. W. ¼ Sec. 32, nearly on the axis of Pigeon Point. This rock is charged with graphite, in the form of nodules from the size of a pin-head to ½ or ¾ inch in size. Some pieces are two or three inches across, and in the working for silver in a shaft some were found more than a foot in diameter. The rock also contains some native copper and pyrite. It embraces irregularly angular patches of quartzyte, and over the exposed surface are patches very rich in graphite. There is but little soil. The rock is chipped, and lenticularly and roughly jointed, or laminated. It is stained outwardly with iron rust. This is plainly a metamorphic rock. It can be traced two or three miles east and west. The graphite, while occurring more or less in the rock on either side, yet is found most abundantly in veins and joints in this quartzyte, over a belt 20 to 40 feet wide. (See No. 552).

271. Finely graphitic quartzyte; from the same place as the last.

272. From the vein on S. W. ¼ Sec. 32. This vein is supposed by the parties owning it to be a branch from that wrought on the trail to Parkerville. No working has been done on it, but the croppings show heavy spar, carbonate of copper, and amethystine quartz, the bulk being heavy spar. Runs N. 20 deg. W.

Crossing the graphite belt nearly north and south is a wide vein near the trail to Parkerville, of calcite and quartz, the latter sometimes being amethystine. This was wrought in 1874, by A. A. Parker, at points not far from the south shore of Pigeon Point, but without encouraging results, although the tests made were not sufficient to prove the vein. (See Report for 1878, p. 15.)

273. S. W. ¼ Sec. 32. From a dyke running N. 60° E., crossed by the vein No. 272.

About an equal distance east of the main N. and S. vein (wrought by Parker) is another vein about 8 inches wide, seen near the water level, which widens out toward the north, involved with much quartzyte, and extends, presumably, under the water to the south side of Susie Island, where other working has been done.

The rock, generally, of the region, appears to be quartzyte, but it is crossed by numerous dykes, generally E. and W., which tilt and modify it, rendering it nearly black in some places, and also give it a basaltic form. The mining locations are on veins running nearly N. and S., following joints and other openings in the quartzyte.

274. Coarsely porphyritic form of the igneous rock of the country; from near the trail to Parkerville, about ¾ mile north of the lake shore. This rises in a low hill, and superficially disintegrates into gravel under the weather. This is just north of the point where the trail runs over a stony beach, which by aneroid is 52 feet above Lake Superior.

The large central vein mentioned as occurring on the south shore of Pigeon Point, formerly wrought, can be traced to the valley of Pigeon river, where it appears in a high bluff back of Parkerville. It is here about six or eight feet wide, and has quartzyte on the west side, and a rock similar to No. 274 on the other. It here contains considerable barite. It seens to extend beyond into Canada, to the first range of hills.

The slates and quartzytes at Pigeon River Falls dip south at an angle of 15 degrees. The falls come down in a direction S. E. over a dyke running N. 50° E. A short distance below the falls another dyke crosses the gorge, running nearly E. and W. (E. 10° N.) The falls have cut the former dyke more than half its width, and have 35 feet left.

275. From the dyke at the brink of Pigeon Fiver Falls, running N. 50° E.

276. From the dyke just below the falls running E. 10° N. The falls descend 70 feet purpindicular. These two dykes seem to converge toward the hill where No. 261 was obtained.

277. Porphyritic basalt, from a small Island west of Susie Island, south of the island which furnishes No. 269. This island is caused by this dyke, but has the country quartzyte on the flanks. On the east end and north side it dips a little east of south, or as the slates at Pigeon River Falls. It rises about 25 feet.

278. Is from the east end of the long island west of Susie Island, next south of No. 277; from the main dyke of the island. This island rises about 25 feet and has slates and quartzytes on the flanks—at the west end of the island beautifully ripple-marked. At a small dyke near the west end of the island the slates are caused to dip more rapidly on the west than they do on the east of the dyke. This dyke is about 4 feet wide.

279. From the dyke at the west end of Susie Island.

280. Rock, like No. 269, and in its bearing: Forms the north point that encloses the long bay on the east end of Susie Island,

cutting the quartzitic slates that dip south on each side. These massive dykes have generally the outward form of Roche moutonne, and near the water occasionally show glacial lines running in the direction of the islands.

281. From about half a mile from the east end of Susie Island, on the south shore, the supposed continuation of one of the veins from the main-land of Pigeon Point. It shows heavy spar only near the water, but the vein itself is about three feet wide,* the ore (bornite (?) and chalcopyrite, being distributed through the dark rock-mass of the vein, which seems to be a breccia of basalt of the region. There are a number of similar veins (four of them), but showing no spar, running in the same direction near this vein, some of them being as wide; and still further east are several more.

282. Prophyritic greenstone, from the main dyke of the north part of Susie Island. This contains orthoclose and plagioclase as well as some quartz and hornblende.

There is a spar veining running E. and W., or with the direction of the island. visible under the water near the shore, about ¼ mile west of the vein numbered 281. It is about 8 inches wide, and can be seen about 25 feet. It pinches out toward the east, and seems to also toward the west. There are several narrow spar veins crossing Susie Island, and the little island next west, nearly at right angles.

283. From the larger little island at the west end of Lucille Island. This rock outwardly appears to be exactly the same as the last, but it contains some pyroxene and no quartz.

284. From the main dyke (?) of Lucille Island, on the south side. The dyke itself is horizontally basaltic toward the west end of the island; and a part of the height of the island is caused by a heavy overflow, but perhaps not from this dyke. This dyke "hades" to the south, and is a coarse porphyritic greenstone. The samples are from that part that is dyke-like. The surface slopes toward the lake. In other parts this island is certainly bedded, and embraces parts of the slates, all dipping south; but the slates are nearly lost in fusion.

Lucille is the highest of all these islands, rising about 100 feet. There is little or no slate on the outer islands, but more and more on those toward the shore,

285. Red rock, from the first island N. W. of Belle Rose Is-

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*Late working on this vein proves very promising, the vein itself becoming more defined, and wider, a few feet below the surface.

land. The south side of this island is conspicuously red with this rock, but the north side appears of the usual color. It is embraced between two or three narrow basaltic dykes. As the dykes crumble by reason of their more close jointage, the surfaces of this red-rock stand out in view. The island next further N. W. appears reddish the same way on the south side. None are red on the north side.

The island south of Lucille Island is a bare rock, in form like the rest mentioned, but has no soil, rising but little above the water.

286. Black basaltic rock, from the narrow dyke adjoining No. 285.

These islands, with perhaps the exception of Lucille, are all built on the same plan. They are igneous at the center, and are sometimes associated with some slate on the flanks. They are sometimes composed of two or more large dykes, and frequently show crossdykes radiating from the main line. The dykes are shaped and distributed as the slates broke on the upheaval of the land-ranges or hills, since the slates always dip toward the lake. These dykes have no effect on the dip of the slates—with perhaps one exception, which is visible on the south side of Lucille Island, near the west extremity, where there seems such irregularity as to suggest an independent fracture or outflow.

Lucille Island consists mainly, so far as height is concerned, of successive beds of massive greenstone, which in their lower parts are somewhat slaty, as if the slates at first were embraced, and they all dip lakeward, but a wide dyke runs from one end to the other. The islands are scantily wooded, the slaty ones more so.

The point that encloses Morrison's Bay is a quartzyte monoclinal, that dips to the lake. The bay has a pebbly beach, but with rocky outcrops of the same kind near the bite of the bay, and also on the coast about north from the point. The last runs east so as to enclose Clark's Bay in the same manner. The point, however, enclosing Clark's Bay terminates by a dyke about 20 feet wide, which runs also through the islands off this point. The islands and the point have the same structure—an immense dyke that "hades" to the south. In this dyke near the point are two crooked cores of calc and heavy spar carrying pyrites.

The coast of Clark's Bay is wholly rocky, except a short inverval at the head of the bay, and the hills on the north side rise perhaps 125 feet, composed of a huge dyke that forms, apparently, the axis and core of Pigeon Point peninsula. The points enclosing Clark's and Morrison's Bays are nothing but repetitions of the off-lying islands further southwest—sudden outbursts of trap through fissures in the quartzyte causing scattered islands, or sharp elevations. Back of these two points are traces of the lake-shore action, that once actually made an island of Clark's Bay point, and also ran far inland back of Morrison's Bay. The same phenomenon is repeated in Pigeon Point itself. It was formerly an island, and Pigeon Bay was connected with Wauswaugoning Bay. Low flat land now occupies the intervening space as a terrace of Pigeon river. Parkerville is on this flat (or "cypress swamp"), which extends to Wauswaugoning Bay, being about a mile and a quarter in area.

287. From the big dyke (like No. 274), the axis of Pigeon Point, near the location of Baker & Kendrid's barite vein.

288. Fine green rock, from the shaft at the barite vein.

288. A. Calcite, barite, &c., from the shaft.*

288. B. Samples from vein (b) near the shaft.

289. The country rock, at the barite vein. This is $\frac{3}{4}$ quartz.

290. Fair samples of the quartzyte of the region—the chief rock of Pigeon Point peninsula, as exhibited on the south shore: obtained three miles west of the extremity. This is a dark-red or brownish quartzyte becoming black near the dykes, and in some places having red orthoclase mixed with the quartz grains.

Quarter of a mile east of Kindred & Baker's shaft is a dyke 45 feet wide that runs south 40° E. It is unnecessary to mention and sample all the dykes, some of which are narrow and run in different directions. A large dyke terminates, or runs under the lake, with a high hill at the shore, at the point where the section line between 26 and 27 strikes the south shore. Three smaller dykes terminate in a similar way a few rods west. Other points are formed in the same way. At the canoe portage Canada can be seen across the point, and the point is very narrow. This high point is just west of this portage. Approaching the extremity of the peninsula, the igneous rock becomes more frequent in outcrop, by being interbedded, and by frequent branch dykes. The dykes rise like those in the islands and fall again soon. (See Nos. 604-616.

291. From the extremity of Pigeon Point Peninsula (compare No. 603). This seems to be the principal rock axis of the peninsula, and probably in the line of bearing of Nos. 287 and 274. This rock is not evidently a dyke here, but a massively bedded, or

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*For a brief account of this location, and the ores found, consult the Seventh Annual Report, p. 16.

coarsely jointed formation which extends west, and soon rises over 50 feet from the water, and shows a basaltic, mountain-like structure. It resembles the rock and structure of Rice Point, and may be parallelized with it in age, and here is associated, as there, with a red, metamorphosed rock. Here, however, it is a part of the Animikie beds, of Dr. T. Sterry Hunt, which would therefore seem to be only a downward extension of the Cupriferous Series. This rock breaks down at the canoe portage, about a mile west of the extremity of the peninsula, and only a pebbly beach forms the continuation of the land, which is but few rods across.

292. The next rock, just west of the canoe portage, on the north shore of the peninsula, forms a similar kind of coast; also is heavily jointed and bedded like No. 291; but it is red with orthoclose. The microscope reveals also hornblende and quartz; occasionally, also, is a grain of a milk-white, foliated, soft mineral. This is a granular rock, derived from the fusion and crystallization of the associated sedimentary beds. It weathers and parts as if a conglomerate near the water. This rock continues but a short distance, making one blunt point, when the features and color of No. 291 return again. (See the notes on Nos. 604–613).

293. From the north shore of Pigeon Point, about a mile and a half from Pigeon river. This forms the coast line, and high hills, and fairly represents the north shore of the peninsula from the Point to this place. There is no quartzyte. Near this point is a high bluff of fine basalt, closely and irregularly jointed, crumbling out in small angular pieces, continuing about 50 feet, forming a round, broad point.

At about half a mile from the river the coast-rock changes, becoming quartzyte and slate, dipping to the south. Just here, or within a rod or two, appears the baryte vein that is shafted by Kindred and Baker on the south side, but it is in the slates and quartzyte. It is about 25 inches wide. It here runs E. 25° S. The mass of the vein is baryte, but seems also to contain calcite, as the baryte is porous and cavernous, and is separated from the walls by solution of some other minerals. The same ores in small quantities are visible in the veins and small included altered pieces of slate or quartzyte, especially the pyrite. The slates and quartzyte continue to the mouth of the river, but there a range of hills sets in immediately on the south side, which continues to the south of Parkerville, where they consist of coarsely porphyritic rock, like the rock No. 274. These hills are wooded down to the river. This range dies out before reaching Wauswaugoning Bay, and to the north runs a larger range from which was obtained No. 261. West of the last vein mentioned, about 400 feet, is a two foot vein of calcspar, near the mouth of Pigeon river, running S. S. E, in the traprock of the country. It dips slightly to the east. No working has been done here. Superficially it shows only calcite, sometimes saccharoidal.

Mayhew's location, which is about 3 miles west of Cascade river, comprises a series of veins in a loose network, running in various directions, varying from ½ inch to 6 inches in width. They appear under the water near the shore, and show white, embraced in the traprock of the country. They contain calcite, laumontite, stilbite and other minerals. The ore is what is styled "gray copper ore," but without the authority of any analysis by the survey. It appears like that from the vein on Susie Island, south of Pigeon Point. The rock round about is frequently veined, and parts with red "heulanditic" coatings, so named by Norwood. It crumbles, on weathering, to a coarse gravel, of a dirty green color. It also has hæmatitic red spots on the weathered surface. The main direction of the net-work of veins is W. 19° N., having a width of about four feet. But the lead that has been wrought by shafting produced masses of the ore from between wall rocks, indicating a width of ore of 4 inches.

From Grand Portage to Squagmaw Bridge, along the International Boundary.

From Grand Portage Bay the portage trail follows the main creek about a mile and a half, when it leaves the valley of the creek and continues more nearly in a right line, but to the east of the creek. At three miles on the trail it crosses a creek which runs northward into Pigeon river and is cut about 50 feet into the non-terraced deposits of the plain. The trail rises 537 feet above the lake at a point half a mile south of this crossing, the ascent being gradual all the way, and nearly in a right line, over a glacier deposit that also gradually rises from the flat on which the church stands at Grand Portage. A glacier valley now filled partly with till extends thus northward from Grand Portage, and has by its smooth upper contour determined the location of the portage trail. Before reaching the highest point there is a level tract of half a mile of glacier clay, good land, once timbered, now burned over. Passing the notch in the hill range, the trail soon descends about 70 feet to this creek, and the main glacier plain, which is here a mile wide (No. 5), and rises toward the northwest. The ice-movement was toward the east or southeast, sending a spur from the glacier through the notch where the trail goes, that finally reached Lake Superior. The principal glacier plain is bounded on the north by another range of hills resembling those along the south side, thus holding this ice-flow in a trough. This plain is a fine tract of clay land, suitable for all cultivation adapted to this latitude. The soil is not strong, but mostly a fine clay, or a pebbly clay. The hill immediately south of the creek crossing rises, by aneroid, 335 feet above the creek, and 225 feet higher than the trail.

294. A globuliferous weathering doleryte (perhaps a melaphyre), from the hills next north of the glacier plain above described, near the point where the "Arrow river trail" crosses them.

The hill to the south of the creek-crossing, rising about 355 feet above the creek, is of igneous rock, dark colored, weathering grey, consisting of plagioclase and pyroxene exactly like the rocks of number 294, 293 and 291, and this rock seems to constitute the whole of the hill, and of the country about. Yet judging from the slate seen along the lake shore, forming the lower slopes of the hills, the slate and quartzyte formation is the real rock of the country, and this igneous rock simply has been thrust through it. Being more firm, and afterwards glaciated, it has come to be nearly the only rock visible. This is also farther indicated by the presence of much fragmentary slate in the drift clays of the valley, and even of some fragments of slaty quartzyte on the upper slopes of this hill. There are also some gneiss boulders on the very top of this hill.

This hill is only one of a short series running about N. E. and S. W. overlapped *en echelon* by others further east. There is here no evidence of any extensive dyke, or line of fracture in the stratified rocks continuous in one direction, but rather of several short fractures.

From the creek crossing above mentioned the trail ascends gradually over a deposit of till, mainly smooth, to the summit of the portage, 782 feet above Lake Superior, and five miles from Grand Portage village. This clay deposit was once wholly wooded with pine, aspen, birch, spruce, tamarack and cedar; but in 1873 it was devastated by fire accidentally set by an Indian. The hills also were timbered but now are charred and treeless as far as the eye can discern. Toward the northwest, this smooth clayey drift deposit continues to the summit near which is a frequent stopping place for voyageurs. A low cleft, among some trap rocks, near the trail on the right, furnishes water and a half way stopping place. The whole country here, however, is high and clay-covered, nearly on a level with the top of the hill at the creek crossing. The water found is on a lower level, and on the descent to Pigeon River. By Aneroid, Pigeon River at the end of the trail is 697 feet above Lake Superior.

There is but little rock exposure on the trail, after leaving the creek crossing mentioned, and the most of that is near the upper end of the trail, or within one-half mile of Pigeon River. In one place the trail passes over a glaciated surface of rock No. 294, nearly in the line of the range from which 294 was taken, but further north, but the rock does not rise above the trail. In passing further, a few other similar exposures occur, but some of them are of a harsh non-igneous rock, somewhat slaty in places, viz:

295. Bedded, of a greenish-gray color, fine grain and somewhat slaty structure; near the upper end of Grand Portage trail; probably from the slaty formation of Grand Portage. Just below the portage landing Pigeon River has a little rapid and then all the way below there is no possibility of canoeing till after passing Pigeon River Falls near Parkerville. The rock which first appears near the portage landing is No. 295, dipping S. 10° E. at an angle of about 10 degrees. The course of the river here is north: it continues about a mile northwestwardly (up stream) when a portage of ½ mile is made up an ascent of 67 feet. This is known as Partridge Portage. Except a strip of about two miles on the grand portage beginning at 4¾ miles from Grand Portage village, the whole country is burnt off. Immediately below the upper end of Partridge Portage is a fall in the river, nearly perpendicular, of about 40 feet. The rest of the descent is in the rapids. The brink of the falls is of slate, ripple-marked, dipping S. about 12 degrees.

296. The slate of the brink is immediately replaced in the gorge by a dyke (296) which at first is perpendicularly jointed; but after about 75 feet it becomes more globuliferous-weathering, and crumbling. These two aspects together occupy a distance of 110 paces down stream, and are the axis of the uplift producing the hill range. This is supposed to be the same hill range as that from which was obtained No. 294. Below this axis comes a rock like No. 295. This dyke No. 296 is nearly cut through in the recession of the falls, there being but a few joints of it left standing vertical toward the foot of the fall. These break the fall of the water. The slate will probably endure the erosion better than

the dyke, its position (dip up stream) affording greater protection from the current. The dyke here runs W. 5° N. About 25 feet below the foot of the fall, a narrow vein of pyrite and calcite crosses the gorge. In high water it is entirely covered. The perpendicularly jointed part of this dyke which receives the impact of the falling water at present, has very much the aspect of being a metamorphic condition of the slates themselves; basaltified by the real igneous rock which is seen to crumble with a globuliferous disintegration.

Canoeing about four miles the ascent is about 5 feet, when the river becomes shallow and the canoe is dragged slowly for nearly a mile. the ascent being 17 feet. to English Portage, when an ascent of 15 feet ensues. the portage being about ¾ mile. At the upper end, where the rapids occur, is a low exposure of

297. Rock like No. 296. Toward the S. W., about a mile, is visible a hill rising about 300 feet above the river. This rapid is a part of the effect of this hill-range. Another hill, on the Canadian side. is in range N. E. from this, the rapids being between them.

Above English Portage canoeing one mile gives an ascent of 3 feet, when the fourth portage is reached. This extends about ¾ of a mile, with an ascent of 25 feet. Adding for ascent to the foot of S. Fowl portage (canoeing) 2 feet. and for the ascent of S. Fowl Portage (5th portage) to S. Fowl Lake, 102 feet, the hight of S. Fowl Lake above L. Superior is found to be 933 feet.

The two portages below the S. Fowl portage afford no rock exposure. A hill range, however, can generally be seen off south of the river, one or two miles away, between the last portage and S. Fowl Portage. The drift clay is everywhere red. The S. Fowl Portage is one mile long. A trap hill rises to the hight of 1,260 feet above Lake Superior, just at the landing place at the head of S. Fowl Portage, near the foot of S. Fowl Lake, which is perpendicular from the lake shore, except a coarse and high talus. This hill is 327 feet high, by aneroid, but it is only one of a series of hills running west 25° N., two of which, about 100 feet higher than this, are on the United States side of the river, and also near the lake, but bearing away from it. West from this (or S. W.) is a high and large range of wooded hills running N. W.

298. Is the basaltic rock composing the top of the hill at the foot of S. Fowl Lake. At the foot of this hill, on the west side is a copious talus, which also lies in a shaded gorge which slopes N. and is protected from the warm sun of the summer. At the foot

of this talus, where this gorge approaches the lake, near the end of the trail, is a spring of ice-cold water, which is said to never dry up, nor to become warmer. It is probably fed by perpetual ice protected in this gorge by the coarse fallen pieces of the talus from the warmth of summer. The presence of this perpetual ice is further indicated by the rank mosses growing on the rocks about, sustained by the condensed moisture due to the coolness of the gorge.

About one-third of the hight of this hill is composed of the black and quartzyte slates, dipping south at an angle of about 8 degrees. This is visible and most accessible on the north face of the bluff. The rest above is an igneous overflow, in basaltic structure perpendicular to the slate beds.

299. Fragment of the slate from below No. 298; ten feet below contact.

At the outlet of S. Fowl Lake, which is between two bluffs of igneous rock, the west one being about 100 ft. high, there is a dyke of black basalt about 8ft. wide, passing through the doleryte (298) running E. and W.

A short distance above N. Fowl Lake, is the foot of the 6th portage, going over Canadian soil, which, with a partial unloading of the canoe before reaching it, on account of shoal water, amounts to about ½ mile, and ascends 48 feet, to the level of Moose Lake, 985 feet over L. Superior. Ascent over South and North Fowl Lakes perhaps 4 feet. It is noticeable that more land is burnt over along here on the United States side of the boundary than on the other. Some tracts largely covered with pine at first have been devastated on the United States side, especially along North Fowl Lake and Moose Lake. The south side of Moose Lake is formed by slate hills, or a ridge of slate made by the strike, the dip being toward the south or a little west of south. The country is largely drift-covered ; indeed has been everywhere glaciated, but as yet it has been impossible to ascertain, by glacial marks *in situ*, the direction of the movement, though it was probably the direction of the valleys, eastwardly or south-eastwardly. The forms of the hill-tops, and particularly that at the foot of S. Fowl Lake, are like that seen in the Saw Teeth Mountains, and generally along the shore of Lake Superior. They slope gently toward Lake Superior, but are precipitous or perpendicular toward the land. Hence, looked at obliquely from a distance, they occur in very much the successive outline as the teeth of a saw. It seems as if the precipitous sides facing the northwest are caused by the action of glacial ice on the geological structure. If the hills are entirely of igneous origin, and their axes are deep dykes running to the interior of the crust, then they are bald and basaltic on that side because of the greater violence of glacial forces from that direction. But if the hills are caused by overflows of igneous matter, with the strata below dipping towards the lake, the saw teeth form has been wrought out more easily by the combination of glacial causes with a favorable direction of dip,—which is the case in the bluffs south of S. Fowl Lake, and east of N. Fowl Lake.

300. Coarse, almost porphyritic, igneous rock. S. W. ¼ Sec. 30, T. 65, 3 E., from a hill composed partly of this and partly of slate. This hill rises 485 feet above Moose Lake, 1,470 feet above Lake Superior, and 2,070 feet above the ocean, being one of the highest points yet measured in the State. This is but one of a series of similar hills, some of which perhaps rise higher.

West of Moose Lake is the seventh portage, on the Canada side of the boundary, about ⅓ mile long, rising 130 feet. This trail passes through a surveyed mining location. It goes over the slates of the country, though the rock is oftener a gray quartzyte than a true slate. It is interstratified with what appears like true roofing slate, and is often black with contained carbon. It is all apt to be in beds less than 3 inches thick, but the gray quartzyte also appears sometimes in beds of 6 or 8 inches or a foot. The Pigeon river here is very insignificant.

Passing a small lake the eighth portage begins, which is also on Canadian soil, and about 1-6 mile long, ascending 15 feet.

Passing another small lake the canoe route has its ninth portage which leads to Mountain Lake. These two small lakes are styled Twin Lily lakes, named from the abundance of *Nymphæa odorata* which spreads its leaves all over their surfaces. Mountain Lake is 1,150 feet above L. Superior.

There is a hight of land on the section line between Secs. 21 and 22, south of the "narrows" of Mountain Lake, which rises 353 feet above Mountain Lake, or 2,103 feet above the ocean, being the highest land yet measured in the State. A few rods further west the ridge rises 15 feet higher, and in the distance (S.) is a ridge which is probably the real "Mesabi," which rises several hundred feet higher.

These hills are all short mono-clinals of gray quartzyte, with beds of argillaceous and black slate, dipping uniformly in a southerly direction, and covered with a greater or less thickness of the traprock of the country (like No. 300), the trap sometimes being over one hundred feet thick, but generally less than fifty feet, and often the only rock seen, the lower beds being hid by the copious talus. The slate in some places has a dip slightly S. W., and the inclination amounts usually to about 8 or 10 degrees. The trap itself also dips with the slate, so that the hills have gradual slopes toward the south and steep slopes toward the north, or are perpendicular—indeed they most frequently are perpendicular for about 25 feet from the top, or even 100 feet, the trap having a widely basaltic structure, which causes it to fall away in perpendicular columns; the slate and quartzyte also have frequent perpendicular jointage planes, which also facilitate the perpendicular breaking of these beds. The quartzyte is evenly and conspicuously bedded without any confusion, but alternates both gradually and suddenly, with the black argillaceous slate. The most of it, so far as seen to this place, is gray quartzyte. This quartzyte must be an immense formation, as it is that seen at Grand Portage, and all over Pigeon Point and the islands of the point. Still it cannot be estimated, fairly from what appears to this place along the boundary line, since that line nearly coincides with the line of strike.

Several important questions, pertaining to the geognosy of this formation, arise in an attempt to describe it, which must for the present remain unanswered, but which perhaps future examinations may solve.

1st. Is this trap older than the uplift of the hills, or did it come over the country when the uplift occurred?

2d. Are the dykes that are seen crossing this trap (as at the foot of S. Fowl Lake) of the same age as the trap, or are they subsequent to it?

3d. How much of the topography here is due to glaciation?

4th. Do the monoclinal hills run under each other, or are they each separate and isolated uplifts?

5th. Can these beds of supposed igneous rock be due to a change in the sedimentary rocks instead of igneous overflow?

6th. Why is there an entire absence of amygdaloid?

The portage from Mountain Lake to Rove Lake descends 3 feet, passing over a divide of perhaps 20 feet high between the two lakes. Hence the "dividing ridge" on the boundary line is 1170 feet above Lake Superior, or 1770 feet above the sea level.

301. Vein matter from Kindred and Baker's shaft on the White Rose vein, near Arrow Lake in Canada. This is about 1¼ miles north of the east end of the first lake west of Mountain Lake.

For an account of this location the reader is referred to the Seventh Annual Report, p. 17.

302. Vein matter from Baker's shaft on the White Rose vein.

It seems a common thing to see quartz veins near the perpendicular walls of the mono-clinal hills, as if by a series of faults they had been located there on the upheaval and breaking of the rock. They are apt to be hid by talus on the north side of these hills, but are sometimes seen standing by the side of the bluff, or adherent to it, some distance above the talus.

Daniel's Lake is 28 feet lower than Rove Lake or 1119 feet above Lake Superior. Some very high hills of slate and quartzyte, covered with the trap rock of the country, are along the south side of Rove Lake running westward to the south side of Daniel's Lake.

The portage from Daniel's Lake to Birch Lake (Bearskin Lake on the plats, wrongly named by the surveyors) ascends 24 feet; from Birch Lake to the lake south of Birch Lake the portage ascends 7 feet; thence to the lake on section 6, T. 64 N. 1 E. 51 feet, making this lake 1201 feet above Lake Superior; thence to Bearskin Lake, descent 23 feet; thence to large lake N. E. ¼ Sec. 9, T. 61, 1 E. descent 16 feet, 1162 feet above Lake Superior.

There appears to be no change in the geology of the country, except that the mono-clinal hills of quartzyte covered by trap, are not so high as along the lakes further north.

The portage from the last lake is on S. W. ¼ Sec. 1, and descends 6 feet to a lake on S. W. ¼ Sec. 1; thence a portage to Fanny Lake ascends 14 feet, making Fanny Lake 1170 feet above Lake Superior. For an account of mining operations on Lake Miranda, by Mr. Wm. P. Spalding, the reader is referred to the Seventh Annual Report, page 18.

Lake Miranda is 61 feet higher than Lake Fanny, and Pine Lake is 279 feet lower than Lake Miranda. The highest lake level yet measured is Lake Miranda, 1231 feet over Lake Superior.

Descent to McFarland's Lake, *via* Pine river, 1 foot; McFarland's Lake over Lake Superior, 951 feet. John Lake is about a foot lower than McFarland's Lake. The descent to S. Fowl Lake must be about 18 feet, according to the ascertained level of S. Fowl Lake.

Consult the Seventh Annual Report for an account of McFarland's mining location, page 20; also of Johnson's on the S. E. ¼ Sec. 32, T. 65, 3 E.

About ¼ mile east of Johnson's shaft is a bare glaciated surface of trap, crossed by the trail from John Lake. The whole surface slopes south, toward the axis of the valley, and the marks generally run N. and S. and some also E. of N. and W. of S. There is here also a superficial checking, or chipping comparable to that seen in Rock county, but less closely set. The checks appear by the shape of the pieces, that come out after burning, as well as by the freshly uncovered surface where no fire has loosened them. Their concave sides are generally toward the northwest.

303. Apparently auriferous quartzyte from the large quartz vein near the south shore of Pine Lake, on S. E. ¼ Sec. 31, T. 65 N., R. 1 E. (Consult the Seventh Annual Report, p 21).

The small lake at the east end of Cariboo Lake is 90 feet higher than Pine Lake, and Cariboo Lake is 5 feet still higher, or 1047 feet higher than Lake Superior. Clearwater Lake is 1159 feet over Lake Superior; thence to Mountain Lake is a descent of 5 feet, making Mountain Lake again, after a series of scattered aneroid observations since leaving it, 1154 feet above Lake Superior—or 4 feet higher than by the former observation. This check on Mountain Lake, after an interval from Sept. 7th to the 15th, and through a line of elevations carried through Rove Lake, Daniel's Lake, Birch Lake, lake south of Birch Lake, lake in Sec. 6, T. 641, Bear-Skin Lake, lake N. E. ¼ Sec. 9, T. 64, 1; lake S. W. ¼ Sec. 1, Fanny Lake, Miranda Lake, Pine Lake, McFarland's Lake, Pine river, small lake east end of Cariboo Lake, Cariboo Lake, and Clearwater Lake, with intervening portages and various weather, is a proof of the usefulness and also the correctness of the aneroid observations.

On the portage from Clearwater Lake to Mountain Lake the trail passes over an interval near the summit of the divide where the quartzyte dips N. W. Several short, low, sharp monoclinals occur, crossing the trail diagonally. They are inconspicuous compared with the mono-clinals dipping in the other direction. The high hill, however, facing on Mountain Lake, just east of where the trail strikes it, dips in the opposite direction. Another point where the slate dips northwardly may be seen along the east end of Caribo Lake on the north side.

In making the portage between Mountain and Rove Lakes one is struck with the simplicity of the international boundary line. It is the narrow, crooked Indian trail running between the lakes, and the United States land surveyors meandered up to it and set stakes, the same as to a lake shore.

Mud Lake is 125 feet below Rove Lake. The trail, in passing over this portage, runs on the top of a ridge which has the appearance of a kame, for the distance of fifteen or twenty rods. This is somewhat nearer Rove Lake than Mud Lake. The ridge is steep on both sides, and over 50 feet high in some places. In others it is narrow and slightly deflected from its course. It runs rudely parallel with the valley in which the trail lies.

While the general explanation, already given, of the structure of the hills of this country is correct, yet there are exceptions and irregularities throwing the dip out of its southerly direction. Sometimes the crust seems to be faulted on both sides, or nearly all sides, of a hill, the trap rising basaltically above the talus nearly all round.

High hills border Mud Lake, especially on the south and west sides. The drainage from Duncan's Lake into Mud Lake, and thence to Arrow Lake and Pigeon river.

Rat Lake is 6 ft. higher than Mud Lake, *via* Rat Portage; and South Lake is 29 ft. still higher, or 1057 feet above Lake Superior. The outlet of South Lake is into Rat Lake. North Lake has the same level as South Lake.

Between North and South Lakes is a low divide, perhaps 40 feet higher than the lakes, which actually forms the divide between waters flowing to Lake Superior and to Lake of the Woods, and should be so designated on Minnesota maps, instead of the divide between Mountain and Rove Lakes. Mountain, Rove, Mud and South Lakes discharge into Lake Superior, but take the Arrow river channel through Canadian territory, to reach Pigeon river. This divide then is 1097 ft. above Lake Superior, and 1697 above the sea. North and South Lakes, being on the same level, probably have a connection, but their overland visible outlets flow in opposite directions. The divide between them is a low ridge of the usual trap of the country. The south shore of North Lake has a sandy beach at the portage landing, plentifully intermingled with colored flint and jasper. The "gunflint" beds are reported to be exposed on the portage trail from North Lake to Northern Light Lake, and between North Lake and the next lake north.

304. Guided by this, and the topography, the same beds were discovered in the long, low point separating North Lake into two arms. These beds are confused, but yet a part, probably, of the quartzyte formation seen all the way from Pigeon Point to this place, and underlie it. They are nearly a red jasper, or jaspery bloodstone, in some places red, but varying also to blue and greenish, and passing also to white quartz, the greater part being blueish-black. In the bloodstone the matrix of the red globules weath-

ers away faster than the globules themselves, producing a reticulated fine roughness on the surface.

305. Near the head of the bay, just east of the first narrows, in the outlet to North Lake, is an outcrop of this rock on the north side of the boundary. This, of course, underlies the gunflint beds. It is a granular rock, crystalline, rather coarse, firm and dark colored, containing much amphibole. Its other constituents are orthoclase and quartz, with a little biotite. It is in low, irregular knolls, and is veined and blotched with irregularities of composition, one vein being the next number. (Compare No. 718).

306. Which is finer-grained, much lighter-colored and consists almost solely of grains of quartz and orthoclase, with scattered films of biotite.

Passing through the "narrows" there is a descent of four feet, into a slow, broad stream or narrower portion of the bay, known as Gunflint river. These narrows are not represented on the surveyors' plats.

There is, along this bay and stream, an unseen interval between Nos. 304 and 305, which may amount to two or three hundred feet, the space being occupied by water.

307. From the Gunflint series, a mile further west, on the south side of the long arm, very irony and carbonaceous. The quartzyte formation seems to graduate downward into the gunflint rocks. This rock is a carbonaceous and pyritiferous shale, firm and heavy, with flinty nodules, not well exposed, but embracing perhaps two feet.

There is a considerable current, and a descent of about one foot into Gunflint Lake, which, therefore, is 1,052 feet above Lake Superior.

A beach of coarse sand along the head of this lake, as well as that on the south shore of North Lake, presents a novelty in the characters of the shores of the northern lakes, which are generally either of bare rock *in situ*, or of pieces from the bluffs adjoining. This sand seems to imply a rock easily disintegrating in this series. The sand itself consists mostly of quartz and orthoclase, some of it being of granular rock like No. 306.

308. The trap of the country; south side of Gunflint Lake. Sec 24 T. 65, 3 W. (Compare Nos. 721-27).

309. Hydromica slate (?); from the north side of Gunflint Lake, about half way from the eastern extremity. This rock rises in knolls and hills one above the other irregularly disposed. The

slates stand nearly vertical, running E. 20° N. This passes insensibly into the next.

310. Rock, magnesian, yet harsh and firm, with grains of free quartz; of a light green color. Into this the slate graduates, back and forth. This resembles some forms of the slates at Thompson, on the St. Louis river. (See 469).

311. Greenish porphyritic rock (with albite?) having an imperfect, schistose and fibrous structure, and some free quartz; embraced much like veins in the slate No. 310. It is not vein matter, but gradually changes to the slate right or left, the slates standing nearly vertical and running E. 20° N. In this slate are also some large veins of milky quartz.

This outcrop is supposed to belong to what the Canadian Geologists have styled the Huronian. It underlies the quartzyte and gunflint beds, apparently unconformably. At least it is another and distinct formation from the slates at Grand Portage.

On the south side of Gunflint Lake, a little further west than the last, is a low outcrop of rock like No. 312, which occurs strewn in fragments along the beach more or less on the south side of the lake, and at the east end. When broken freshly it has the appearance of a gray quartzyte embracing fragments of flint, or finer quartzyte, somewhat like a conglomerate. The matrix is coated, on the weathered surfaces, with a film of iron-rust derived from the rock itself, but the siliceous fragments it embraces are not so coated. This appears again, in a low exposure, on the north side of the lake, about a mile still farther west, and here shows plainly a conglomeritic structure and composition.

312. Quartzyte conglomerate; from N. shore of Gunflint Lake, west of the outcrop of Nos. 310 and 311, in a belt running to the south of these. At the exposures of the rocks 310 and 311 the north shore is bent northward abrubtly, bringing the water upon them, the strike of No. 312 forming E. and W. points on either side, enclosing a bay which breaks down and covers No. 312. This conglomerate, or breccia appears on both sides of the lake, nearly opposite. The fragments are of gray quartzyte and flint, all angular, not water-worn. Sometimes the flint seems to run through the rock as if in its sedimentary position. The matrix is coated with an iron rust, derived from the oxidation of siderite which constitutes a large per cent. of the rock, making a permanent film all over it. The flinty pieces embraced in it are not thus coated. The whole is contorted in bedding and broken; it pertains to near the base of the series. (See after No. 927). This

carbonate of iron probably derived the carbon from the associated slates, which are sometimes black with it. In other places the iron is a sesquioxide—or in some places it seems to be disseminated as a sulphuret, as in No. 307.

313. Granite, from N. E. ¼ Sec. 24, T. 65, R. 4 W.

313. Granite (with garnets?), from S. E. ¼ Sec. 13, T. 65, N. R. 4 W. Rock of this kine seems to compose the range of hills that run westwardly from here, and also eastwardly, in Canada. Where this range crosses the river, there is a narrow place, and rapids (2 ft. fall); but south of this the level is that of Gunflint Lake. But in about 40 rods further north are falls and cascades, over the same rock, the descent being 14 feet.

315. Granite from the falls, next north of Gunflint Lake, (same as No. 800). This granite is similar to the rock 305, but has generally less amphibole and more quartz. This and that, and the last belong to the same formation and class of rocks, and are in the same range of hills.

After a descent by the river through rapids, about three feet, a small portage is necessary round a fall in the river amounting to 33 feet.

At the foot of this portage the level of the river was found, in 1878, to be about four feet lower than usual, even for low water, and a wide, freshly drained tract round the shores, showed that there had been some channel lately acquired by the river at a lower level, or that like Sunken Lake, in Presque Isle county, Michigan, some underground passage was at that time able to carry the whole stream, since the river wholly disappeared, having no visible overland flow. The last water seen at this place was 1030 ft. above L. Superior.

Making a portage of about half a mile the trail strikes water again after a descent of 52 feet, at N. E. corner T, 65 4 W. in a lake. Through this portage the rock is the same as No. 313 and 314. The country however is not so hilly as in the quartzyte and slate.

Passing two short rapids, one of 4 ft. fall, and the other of 2 feet, a portage is made on the U. S. side, to the level of a little lake, descending 18 feet, with the same granite all the way. Granite outcrops frequently through this town, along the boundary line, and sometimes has a bedding, though indistinct, that dips to the south. After striking the granite, the country loses white pine, and is supplied more abundantly with Banks pine. Norway pine is also smaller. as well as all other trees. The knobs everywhere are *moutonne-ed.*

Below the last little lake a rapid descends 6 feet; then again by the same means 7 feet in two small rapids; and again 8 feet to Banks' Pine Lake, which is found to have a level of 930 feet above L. Superior. It is a long (4 or 5 miles) narrow lake, running N. N. W., reaching within ¾ mile of Saganaga Lake, its eastern extension swinging to the north and again east and southeast, with islands. Below this lake are two rapids, one of 8 feet and one of 6 feet, bringing the river to Saganaga Lake, with a level of 916 feet over Lake Superior.

316. Granite, from the rock a few rods below these rapids; occacasionally dipping S. (See No. 799).

317. From an island in L. Saganaga, on Sec. 5, T. 66, R. 4 W.

Lake Saganaga* has many islands, and all are of the same rock, scantily timbered with Banks' and Norway pine, with a sprinkling of aspen and birches, and of course spruce, tamarack and balsam in suitable situations.

318. White quartz, from a mass on the east side of an island in N. W. ¼ Sec. 14. This has been some drilled into and blasted, but the quartz seems to be a barren mass. It is milky white, and has no ascertainable direction or form. It makes a conspicuous appearance on the coast, and extends along about 3 rods, rising about 12 feet. It does not appear inland far, nor on the other side of the island. It has an amethyst color sprinkled through it, and some fine galena scales. This rock falls down on the beach in blocks, and is scattered along like the granite. It has a jointing or imperfect, coarse cleavage structure similar to that furnishing the quartz chips at Little Falls. In hammering it breaks sometimes into angular small bits, and in the weather it parts in the same way.

319. On the next island north, at the S. W. corner is an outcrop in form and disposition like the last, but this is not of so pure a quartz. The quartz is somewhat granular and porous, and contains cubes of pyrite, which by oxydation give a rusty stain to much of it. This also has a conspicuous exposure in the midst of the enclosing granite.

320. From the peninsula dividing Saganaga Lake, near the extremity on the N. W. side. There is quite an area here of the same; a variation in the rock of the country, being almost destitute of amphibole (a pegmatyte).

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*The word Saganaga signifies *islands*, or *many islands*, and seems to be the plural of Saginaw.

321. From the same peninsula about 1½ miles further west; consisting of quartz, orthoclase and chlorite, essentially being another variation in the rock of the country. The coast along is pebbly and stony, with occasional sand beaches in the bays. This rock, No. 321, appears to disintegrate more easily than the former numbers, and rarely appears on this coast. At a point near the first narrows the same rock is found in more frequent, and bolder, exposure, on the Canada side. At this point a short portage is made toward the W. into a small lake, over the rock next, with an ascent of two feet.

322. A finer-grained rock like No. 320, but containing some pyrite, from the first portage going west from Saganaga Lake, on the international boundary. This is Oak Portage, from a little burr oak growing there, the first seen on the boundary line west of Grand Portage.

323. The shores of the north side of this little lake are made of a chloritic quartz-schist, of a gray color, being much like one phase of that seen on Gunflint lake, passing to massive (310). This is laminated, seamed and disturbed, but the schistose structure stands nearly vertical, like that on Gunflint Lake, and yet slopes to the south 50° E. in general. It also contains cubes of pyrite.

From the tops of the hills at this place the country is seen to be very rough, presenting a forbidding, inhospitable aspect. It is rocky and burnt off on each side of the boundary, as far as the eye can discern.

The descent by portage into Otter-Track Lake is 40 feet, making Otter-Track Lake 874 feet above Lake Superior.

324. Near the portage, on the U. S. side is a more compact and massive homogeneous condition of No. 323. It is fine-grained, coarsely jointed, of a light green color, and in making this portage the trail passes over the same variation of this rock as that represented by No. 311, on the north shore of Gunflint Lake. Hence this seems to be a recurrence of that formation.

In passing along the south shore of Otter-Track Lake (which is narrow, and about 5 miles long, running S. W.), this formation is sometimes seen to be evenly bedded, and dips at a much less angle (say 10 degrees), toward the south.

The rocks in general along the boundary are smoothed and rounded, the marks of glaciation usually being indistinct. At the Otter-Track Lake the movement seems to have been toward the S. W. in the direction of the valley. The absence of real drift materials is remarkable. There is no clay. and but little of any transported drift of any kind visible. The moutonne-ed rocks rise in hillocks everywhere, and are bare, or thinly covered by recent vegetable mold. Along the lake shore are some strange boulders, but even there the bare glaciated surfaces often run down into the water of the lake. This is particularly true along the south shore of Otter-Track Lake, while the Canadian side is strewn with fallen rock, or is roughly broken according to the joints. The rock bluffs here rise from 10 to 100 feet on each side, the Canadian side being the lee side in the period of glaciation. The U. S. side received the greater friction. The formation dips about south, but different systems of joints cause it to separate in angular blocks, and almost to appear basaltic. No trap was seen between the west end of Gunflint Lake and Otter-Track Lake.

From Otter-Track Lake there is a descent of 4 feet to Knife Lake; the latter being 870 feet above Lake Superior.

325. A light-green, tough magnesian rock, perhaps can be designated a chloritic or serpentinous quartzyte. From the Huronian slate series at the E. end of Knife Lake. This series extends from where first noted, on the Oak Portage (from Saganaga Lake westward), to this place, at least. This number is an important one in the series, as it continues a good part of the distance from the east end of Knife Lake at least to the narrows of the same lake, (bet. Sec. 11 and 12). The rocks all have a greenish color, but are not always slaty. No. 325 is not slaty, and is essentially the same rock as No. 324.

326. Pyritiferous clay slate; 3 miles west of the narrows, on the north shore of Knife Lake, and about ¾ mile east of the portage to the next lake N. W. The pyrite cubes are generally about ¼ inch across.

There is a descent to the next or Maple-leaf Lake, of three feet by a portage going N. W. from Knife Lake; the portage being about ¾ mile.

327. At the beginning of the last portage the rock of the slates varies to a blue-black, fine-grained siliceous rock, approaching flint in hardness and compactness, with conchiodal fracture, and sharp edges; sometimes it is nearly black. It is this sharp-edged rock that gave name to *Knife* Lake. It is only local, or in beds, or sometimes in ridges.

From Maple Leaf Lake the next portage ascends six feet to another lake, being a portage of about 15 rods.

328. At the beginning of the last portage; a clay slate; sometimes

argillyte; standing vertical and running W 30° S. The river from the last lake (near the portage), runs out over this rock in a sort of cascade or fall, the descent being 34 feet, to Sucker Lake, (or Carp).

The size of these lakes is often a surprise to the traveler. They expand unexpectedly, where the prospect is entirely shut off. They are shaped by the geological features. They lie between ridges of the Huronian, and these ridges run approximately E. and W. Sometimes a narrow opening in one ridge allows the lake to spread. Then it enters another narrow valley, and runs in it visibly a couple of miles, when it may jog back again into the former valley by another opening. Only one acquainted could follow the boundary line canoe-route. Sometimes entering a lake it appears small, but on reaching its visible western extremity it turns by a narrow channel and spreads out a couple of miles further west. The portages are short.

The roofing slates (like No. 326), seems to run westwardly, as the last portage goes, to Sucker Lake, and appear again at the Sucker Lake landing. The glaciation along here was to the S. W.

From Sucker Lake the portage to Basswood Lake descends 45 feet, making Basswood Lake 792 feet above Lake Superior. A river of considerable volume reaches Basswood Lake from the south near the point where the portage strikes it, said to come from Sucker Lake. A considerable river from the south enters Sucker Lake about a mile east of Basswood Lake. The beach, at the portage landing from Sucker Lake, is of granite pebbles and sand, but the rock of the country is yet of the Huronian, viz:

329. Dark green massive serpentinous rock, east end of Basswood Lake.

330. Three quarters of a mile N. W. of the point where the portage trail reaches the lake, on the United States side, is an exposure of choloritic gneiss, consisting of quartz, feldspar and clorite, and having a granulated texture, varying to a syenite. The gneissic structure dips about 30° to the west, 20° north. The most of the valley of the lake, to this point, is probably in this rock. The shores of the lake and of the islands are of stones of this gneiss, and are not generally rocky; thus being in great contrast with the shores of the lakes in the Huronian belt farther east, which are almost constantly rocky.

About ¾ mile further, after turning S. W., several points on the south shore show similar rock, but the schistose structure dips, in one case N. W., and in the next nearly south. Again, perhaps a mile further, on an island it dips N. This schistose structure is really a bedding, the beds being about 3-4 inches thick.

331. The rock of the country at Basswood Lake, taken from an island two miles N. W. of the eastern extremity. It is white syenite or "granite". At 2½ miles further it is seen dipping N. W. Again about 2 miles further, after passing the narrows, it still dips N. W. This is at an abandoned post of the Hudson's Bay Company, and opposite a similar station on the U. S. side, the passage between, where the boundary line runs, being only about thirty rods across. The same dip may be seen at other points along here, and in the vicinity of other abandoned posts. The construction of the "Dawson route", and the destruction of fur animals, mainly by forest fires, have diverted and diminished such trading. Before passing all the trading posts the gneissic syenite becomes nearly level, and there shows a slight dip to the S. E. This gneissic structure is very regular, the layers being from two to four inches thick.

Making a portage on this trail to Pipestone Rapids the route crosses an arm of the north shore, which in low water is generally passed by following the lake round by the south. This portage is about 1½ mile S. W. from the trading posts, there being several islands intervening. The portage is short, and at its western end is an interesting series of exposures of rock, exhibiting the interstratification of mica schist (335) with gniess and syenite (336 and 337)—the concordant dip continues from one to the other, showing they are all of one formation and conformable, or that, if of different ages, the Huronian is conformable with the Laurentian. The shore line runs N. 30° E., and S. 30° W., and there is a high dip to the beds towards the south, about 80 or 85 degrees.

332. Near the portage landing, west end, in a low exposure; a fine chloritic (?) gneiss, the bedded structure sloping S. at a high angle.

333. Hornblendic schist, overlying No. 332, an interval hid, being between them; containing also chlorite.

334. Chloritic hornblende schist, conformable with No. 333.

335. Biotite mica schist, separated from No. 334 by a recurrence of rock like No. 332, conformable in dip with the last. This includes irregularly shaped masses or agglomerations of Nos. 336 and 337; also has thin, irregular, interrupted and contorted interlaminations of the same. They are certainly interstratified.

336. Biotite (?) hornblendic gneiss, of a light gray color, al-

ternating along the beach two or three times conformably with No. 335.

337. Similar to No. 336, probably one of its modifications, having more hornblende.

338. Compact, similar to the last, but darker colored; has beds or belts of No. 335, and finally is wholly replaced at the shore line by No. 335 for a short interval, while No. 338 is still visible inland a few rods, in the bearing of the strike, showing a change from one to the other in the direction of the bedding, as well as transverse to it. But a short distance further south the shore is wholly made by No. 338, rising higher, in coarsely jointed and firm, low hills.

339. Hornblendic schist, from the shore of the same lagoon, on the north side, where the same interstratified condition of the same kinds of rocks appears again.

339. B. From the shore near No. 337 and 338, not in place, but supposed to be from these beds.

340. A little further west from No. 339, on the north side of this little water, the rock appears as a micaceous quartzyte, which also varies to

341. A blackish quartzyte (?). somewhat micaceous in some of the interlaminations; which varies, a little further along, in some of its interlaminations to

342. A gneissoid quartzyte, and makes a high bluff, the beds in all cases dipping to the south. Then the rock is hid to the next portage (going to another bay of Basswood Lake, westward).

343. But just where this portage begins the rock forms a conspicuous outcrop of fine syenite, represented by this number.

These numbers (335, 336, 337, 339, 340 and 341) make up the islands and occasional exposures across this bay, but the most is of No. 335*. The portage from this lagoon, in which the above numbers occur, is across an arm of the mainland from the south shore, which is sometimes avoided by passing by water farther to the north.

344. At the other end of this portage, and at one or two spots on the trail, the rock is a tough mica schist. This here also embraces strips of syenite and of quartz. These appear mainly as interlaminations, but also as veins crossing the laminations.

345. The rock along the shore. passing up this long bay, is syenite, but the sample of this number is taken from the place where

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*A similar interstratification of mica schist and granite is described in Ludlow's Reconnoissance of the Black Hills, in 1874 p. 44-45 the first view is presented up the long bay S. W. Hereit is evenly bedded, dipping W. and is of pinkish or flesh color. This continues past one or two small points, when it is seen to dip in the opposite direction. Then on the next it dips again southwest. The surfaces weathered have when smoothed a pink tint.

Further on the bedding is contorted, (along the south coast of of this bay,) and confused, appearing almost perpendicular in short intervals, then dipping again one way or the other. Just beyond this confused place the mica schists, &c., come in again, the beds being almost vertical (i. e. the schistose structure) yet sloping a little to the S. W. This is perhaps a mile from where the route enters this bay. This then continues, presenting the variations already described, to micaceous quartzyte &c., and having at least two systems of joints, one perpendicular to the schistose structure, and one cutting it obliquely, sloping N. W.

346. Passing to the north side of this bay, within a half mile, or perhaps more, the whole changes to a fine, tough gneiss, which has a coarse schistose structure that makes it resemble the schists, being probably only a variation of the schists.

347. A little further along, across the bay, the syenite returns; but here a schistose structure can be seen on weathering, parallel to that seen all along. This forms the coast for some distance on the N. side, at least to within ½ mile of the next portage.

Before reaching the portage a ridge of schists and fine grained chloritic rock appears along the south side, as the bay narrows up, presenting a columnar, or finely-jointed structure, somewhat resembling the basaltic.

348. This is mainly a tough, greenish schist, crushing under the hammer like a chloritic schist, apparently having a dip toward the south, nearly perpendicular, but so broken by jointage planes in different directions, and confused by the schistose structure, that it is exceedingly uncertain. This rock forms the lower rapids at the mouth of Pipestone R. where the water comes down to the level of Basswood Lake, the fall being 10 feet from where the rapids begin, to the level of the lake[*].

Near the foot of the rapids a white quartz vein crosses the river diagonally, running about east and west, but somewhat zigzag. It dips at an angle of about 45 degrees from the horizon toward the south, and is about 5 feet wide. No gold or other mineral can be seen in it, except some pyrites in the grayish rock adjacent to it on the south side. The formation above the rapids is about the same as below, but here it becomes the *pipestone* of this locality. It is simply a schistose, greenish, chloritic (?) rock, being a chloritic (?) slate at a short distance further up the river.

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[*] Mr. Robert Bell questions the existence of Basswood about this lake, and suggests *Whitewood* as a more proper name ; but the real Basswood grows at the mouth of this river, being the most northern known limit of that species in the state.

349. Pipestone, from Pipestone Rapids, a chloritic rock; not much worked nor used.

350. Chloritic (?) slate, from Pipestone Rapids, just above the pipestone rock. This slate stands nearly vertical but dips to the south.

351. About ¾ mile above the rapids the slates dip northwest.

This country contains much pine, but not generally very large. Indeed, the forest is all pine. The same is true along the south shore of the lake before reaching the river. Between the first and second rapids the river expands so as to be more like a lake, without current, and embracing several islands. The lake above the second rapids is known as Kawasachong Lake, and is 8 feet above the water below, or 810 feet over Lake Superior.

352. At the upper end of the second rapids, or a little distance above, near the portage landing, is a white quartz vein in this chloritic rock that makes the rapids. This runs S. 30° W., and coincides with the slate in dip, which is toward the N. W. This quartz embraces rusted pyrite, and has an auriferous aspect.

353. Slate, soft, greenish (talcose or chloritic), from about two miles further up the lake, on the south side. There is not much exposure, but sufficient to show the formation extends to here, at least.

354. A less slaty chloritic slate, from the same place. The slates here run S. 30° W., standing nearly vertical, sloping south. Indeed this direction is about that of the narrow long lake in which the route lies.

The forest along here is not exclusively one of pine, but much white pine of good size is scattered all through it. The country is generally slightly undulating, but not hilly, being much in contrast with that east of Baswood lake. There are low ridges of this slate that cross the country, but they hardly produce a perceptible change in the general surface features.

355. At about a mile further, on the same side, a more massive and siliceous slate appears, showing, also, some white quartz veins. This is probably a variation of the slate, and is exposed but a short distance. The beaches are sandy along here.

A short distance further west the Kawasachong river enters Kawasachong Lake. This river comes from Birch Lake, and along it is a canoe route to Beaver Bay, on Lake Superior. Birch Lake is the third lake south of Kawasachong Lake by this route. The maps generally represent this river as entering several miles too far east.

The Kawasochong falls are visible from the lake. They descend about 40 feet—split and straggling in low water. Here is a large exposure of the same rock as No. 355, but less siliceous, which really appears to be the same as the "pipestone" at Pipestone Rapids. It also contains here narrow white quartz veins and deposits, and some two or three feet wide. One such appears in the river, just below the falls. The falls are within 30 rods of the lake, and the river is one of good size. This rock is neither bedded, jointed nor schistose, but it breaks with a very coarsely schistose manner, and each piece runs to blunt points lenticularly. Chlorite permeates and colors it. It seems to be closely seamed in all directions, but not with any regularity, if we except the general schistoid fracture, which coincides with the slates in being nearly perpendicular, and yet in sloping to the south. It abounds in (talcose? or) chloritic and hæmatitic slickensides. It is everywhere rough, superficially, and mashes under the hammer before breaking, and then breaks toughly.

356. Rock from the Kawasachong Falls on Kawasachong River. The same rock appears on the lake shore at points further west.

At the next point, ¾ mile from the mouth of the river, it appears again more like No. 355.

At the next, 1¼ miles from the river, it is the same.

At the next, nearly 1⅓ mile from the mouth of the river, it is more like No. 356.

The same or similar rock, at least the Huronian slates, etc., continue to the end of this lake, when a portage is made to another lake, avoiding the river on account of very low water, following the "winter trail," which sets out from another arm of the lake further toward the north.

357. Occurs just at the point of the beginning of the "winter trail" from Kawasachong Lake westward; a chloritic slate, running nearly S. W. and sloping to the S. E. This portage ascends 80 feet and descends 17 feet leading to Long Lake, which is thus 873 feet above Lake Superior. On this portage, in its eastern half, are several outcrops of slate like that already noted at Kawasachong Lake, but mainly the country is drift-covered with less rock exposure. Along north of this portage (which is about 1¾ miles long) is a

hilly range running nearly parallel with Long Lake and also with Kawasachong Lake, which appears to be of the Huronian, judged by exposures that are seen along the lake shores. There is still considerable pine in the forest, especially on the south side, the north side being more burnt.

358.' Chloritic or serpentinous rock from an island near the west end of Long Lake; continuation of the same formation as at Kawasachong Falls.

The country at the west and northwest end of Long Lake is more rough and has more exposures of rock. It is likewise more burnt.

From Long Lake the course of travel by canoe is up a river toward the west, perhaps a mile (in a right line), then up a tributary, turning to the right; then after ½ mile further, a portage (½ mile) is made to Burnside Lake, 904 feet above Lake Superior. This portage in general goes N. of W. and over a part of the ridge of hills mentioned as running along the north side of Long Lake. The rock in these hills where crossed by the portage trail is a tough, chloritic rock, viz:

359. Firm, tough, chloritic rock; perhaps a fine-grained protogine from the hill-range running on the north side of Long and Kawasachong Lakes, on the portage from Long Lake to Burnside Lake. This rock at a distance appears gray and granite-like under the weather.

Near the west end of the portage trail, on Burnside Lake,* within an area of 30 feet square, the following numbers, from 360 to 367, both inclusive, were obtained, Nos. 360 and 361 comprising the bulk of the rock.

360. Greenish-gray fibrous hornblende rock, somewhat serpentinous or chloritic.

361. Dark-gray hornblendic rock, chloritic.

362, Glistening chloritic schist.

363. Hornblende schist, chloritic.

364. Granular rock, consisting of hornblende and imperfectly crystalline orthoclase.

365. The same, with quartz and chlorite. The disintegration of this orthoclase produces sandy beaches sometimes about these lakes.

366. The same, with less hornblende, and a reddish color in the orthoclase (?).

367. White, glassy quartz, becoming colored red by hæmatite.

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*This name is a corrupt translation of the Indian word signifying *Burnt-side*.

These numbers are all arranged in a crooked lamination or coarse schistose structure, parallel with the same seen in the slates about here. The hornblende schist (No. 363), and the hornblende and feldspar rock (No. 364) gradually interchange, or pass onward to Nos. 365 and 366. Large masses in knolls and hills lie in the immediate neighborhood, made up of the same rocks.

But further west, on the same side of the lake, the hills are more of the nature of No. 365, yet are in the same way associated with hornblende rock and schist, viz:

368. Chloritic syenite. North side of Burnside Lake.

369. Flesh-colored chloritic gneiss. A vein or layer in No. 370.

370. Chloritic gray quartzyte, compact and hard.

The foregoing are all (359–370) conformable, when they show any stratification at all, which is always the case except when there is a full transition from No. 363 or 364, or even from 360, to No. 368. In that case, when No. 368 is fairly set in the parallel structure, always dipping at a high angle to the south (or a little east), becomes more and more indistinct, or is lost, and in its place a jointage running in different directions, hardly ever parallel with the schists, is substituted. Yet even then, in some weathered situations, a natural parting of the rock brings out a rude schistose structure parallel with that in the slates. It is impossible here to state whether these alternations of rock indicate a coming on of the Laurentian, conformably interstratified with the Huronian, or that the syenite is all in the Huronian. The line of travel through here is nearly in the strike of the Huronian, but has been (since leaving Long Lake) a little to the north, so that if this be a beginning of the Laurentian it comes on, in accordance with the dip, conformably. This series of rocks apparently runs along the north side of Long Lake, some distance from the shore.

The islands and the aspect of the coast and the country about Burnside Lake, traveling on a line a little west of south, appear like those of Saganaga Lake. The islands are nearly as numerous. The rock however is of this transition series of hornblende schists and syenites. The veins of syenite are sometimes white and sometimes reddish, and are often contorted in the schists. They project above the surface, reminding one of the chain coral in the Lower Silurian limestone. The syenite weathers reddish along the lake shore, but the schists do not.

Through Long Lake the glaciation runs S. W., or in the same direction as in Otter-Track Lake. About Burnside Lake, although the rocks are all domed, there is little evidence of the direction of movement. The islands are of bare rock, especially at the west end.

There are places along Burnside Lake, toward the west end, where no bedding nor dip can be discerned, even in the hornblendic rocks, but the whole is disturbed and confused by jointing. But near the river where the route leaves the lake westward, the bedding appears running more south and dipping at a high angle N. W.

371. At the mouth of this river leaving Burnside Lake.

372. At the same place.

These are almost an exact repetition of Nos. 369 and 370, except that No. 372 is more syenitic. Ridges and knolls of this rock here rise fifty feet or more above the lake. Ascending this river about a mile, a portage is then made of another mile to Mud Lake, the whole ascent being 14 feet, or to 918 feet above Lake Superior.

Along Mud Lake the same series of rock continues.

373. Clay slate. From the N. E. end of Mud Lake.

374. Clayey quartzyte (?). From the N. E. end of Mud Lake.

These are from the N. W. side of Mud Lake, in close approximation. The schistose or slaty structure is apparent here, and runs south 30° W., nearly vertical.

375. A quartz or chloritic schist. Mud Lake, at a point a little further S. W. from No. 374, when the lake turns more to the south.

About half a mile further S. W. an old mining location can be seen.

376. From the old mining location on Mud Lake. The rock here is like that of No. 375, but perhaps more compact. It is pyritiferous. It has a gray color, with mottlings of light green and glassy grains of quartz. It is firm and hard, the greenish parts being apparently amorphous with a hardness about 4.

The vein matter here was apparently wholly exhausted by the mining operations. It was a lenticular mass about 20 feet long, and not probably over 12 inches thick, tapering up and down in conformability with the rock enclosing it, and running also in the same direction. The white quartz here mined is apparently the same as that disseminated through the rock, but in larger local abundance.

377. Vein matter, quartz and ore, from Mud Lake. This ore contains plainly chalcopyrite, pyrite and galenite, and probably gold.

378. Quartzitic slate, with talcose partings; from about half a mile further after descending a shallow river-lagoon.

This river is thence followed S. W. to Vermilion Lake, the fall being about 9 feet, making Vermilion Lake about 909 feet above Lake Superior.

379. Chloritic schist from the N. E. end of Vermilion Lake, where the stream from Mud Lake enters it. This rock is like that in a range of hills which continues all the way to Mud Lake, along the north side of this stream, apparently confining the stream on that side, the slates running W. S. W. at Vermilion Lake.

Round Burnside and Mud Lakes, and at the N. E. end of Vermilion Lake the Huronian is rougher, and considerably more denuded, the ridges being higher. At the same time there is no diminution in the drift.

380. Vermilion Lake, at one mile S. W. from the mouth of the stream from Mud Lake; a massive chloritic syenite.

381. The next point S. W. along the S. E. shore of Vermilion Lake, shows a gray horn blendic (?) rock, jointed and with white quartz veins, or deposits in the joints.

382. White quartz, from a vein on S. E. side of Vermilion Lake, running in No. 381. This is a conspicuous white quartz belt, running up from near the water level, a little S. W. from the last point, being a local and irregular deposit, not having much depth. It splits. It stands above the surface nearly a foot. It holds chalcopyrite, which superficially has colors like bornite. It is about 3 ft. thick, and has been dug through by some "prospector."

The schistose structure along here runs but little S. of W. It is indistinct, on account of the rock becoming massive, or only jointed.

Passing a long arm or bay, running a little N. of E. the rock on the first point south of this bay is

383. A gneissic and feldspathic chloritic, gray quartzyte. The schistose structure runs a little S. of W. and is hardly discernible. There is a close jointage that appears here, and at other points, that closely resembles the schistose structure when it becomes slaty, transverse, (nearly at right angles) to the schistose structure. This is plainly a jointage simply, and not anything that affects the tissue, as when a specimen be broken, it breaks with the schistose structure, parallel with it; and if it be from between two planes, or has a joint on two sides, it will persistently remain triangular although it be broken till reduced to too small a size for preservation.

384. Half a mile further along, the schistose structure plainly returns and is W. S. W. and also the chloritic or talcose character. This number is a talcose (?) and at the same time a schistose quartzyte, with considerable greenish-gray, amorphous, feldspathic (?) mineral, and seems to be allied to the rock No. 311, on the north side of Gunflint Lake.

This part of Vermilion Lake is filled with rocky islands.

385. About a mile a little west of south from the last, on a point; a dark colored siliceous slate, or hornstone, mainly in regular and thin sheets, but in some places confused, the slates running W. S. W. and sloping to the south, but nearly perpendicular.

386. On a small island near the S. E. shore; rock like No. 384. Here the schistose structure, sloping S. E. runs S. 50° W. by compass,* and is sometimes a little wavy. In these descriptions *slaty* and *schistose* express variations only, of the same structure.

387. About a mile S. W. of the last the rock varies to a schistose, chloritic syenite, of a light gray color. This is apparently only a variation in the ingredients of No. 386. It is a firm rock, and at a distance appears like massive granite or syenite; yet along the lake shore it parts in a gneissoid manner. It rises higher than the adjacent hills, and is coarsely jointed, so that its rhomboidal parts rise like whitened sheeps' backs. It extends perhaps 20 rods.

388. Half a mile further west the rock is a gray quartzyte, with much white quartz in veins and joints.

389. A mile further west, and near the entrance to the bay that leads to the portage going south from Vermilion Lake to Squagemaw Lakes, the rock of this number which is a gray chloritic schist, is seen to have a nearly east and west slaty structure, varying to a little S. of W. This slaty structure is intersected diagonally by alternations in the rock due to sedimentation, running nearly N. W. and S. E. The kinds of rock exhibited by this alternation are as follows, from No. 389 to No. 394 both inclusive, the former being on the N. E. side and the latter on the S. W. side.

390. Chloritic slate, greenish, soft.

391. Pyritiferous, gray, quartzyte, chloritic.

392. Argillyte, or clay slate.

393. Chloritic gneiss.

394. Siliceous, chloritic slate.

Glaciation across these beds runs N. and S.

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*Magnetic directions in this report are all *by compass*.

At the Government Station, where the Indians are taught to do some farming, which is a little N. of W. from the last point, the New York Mining Company formerly sought gold in the quartz and talcose (?) rock of the country.

395. Fine, soft, hydro-mica slate. This rock has generally been denominated talcose slate. and it may be correctly. This will have to be determined by laboratory examinations. This is from the N. Y. Company's location, at the Government's Station, and the slates run 15° S. of W., and glacial marks 10° W. of S. The strike of the stratification, as mentioned under No. 389, is E. and W., the slates crossing the strata diagonally.

396. "Gold" quartz, from the above mining location. This is white. It is scattered in the joints and irregular veinings in No. 395, similar to what may be seen in many places about Vermilion Lake. (See Report for 1878, p. 23.)

397. The Minnesota Company's location was about three miles north of the Government's Station, on the west coast of a lake, opposite the long point projecting from the N. shore. Here the rock is a coarse chloritic slate, having a close relationship with that of No. 395. The slaty structure runs about E. and W., and glaciation about N. and S., or a trifle east of south.

398. The quartz from this mining location, occurs in the joints of the rock, in irregular deposits, but generally coincident with the slatiness. It carries considerable pyrite, which is also scattered through the slates.

399. Talcose (?) slate, from Simond's location. This is farthest N. W. (or W.) and about four miles from the outlet of the lake; and between this and the Minnesota Company's location was that of Nobles, numerous islands occurring all along. This number represents the country rock. It is siliceous, and contains scattered nests, or broken layers of white quartz, both coincident with the slates and in the diagonal jointage. Pyrite is scattered through the quartz, and through the slates, and particularly in a line of contact where they unite, the quartz becoming gray.

400. Quartz from the same point.

401. Near the western extremity of a point or peninsula that comes near the south shore from the north. A little island here shows rock like that on the north side of Burnside Lake; a mica schist. This is arranged in laminations that run S. 55° W., sloping S., and embraces laminations and wide belts, also conformable with the rest (except where large areas come in) of

402. Syenitic gneiss (and of quartzyte); also

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403. Micaceous hornblende rock, apparently hornblendic syenite.

Where No. 402 occurs in large areas its boundary is not always parallel with the schists, but jogs across a foot or two of them and then runs again parallel, sometimes also crowding them confusedly. This is on the island nearest the point at the narrow passage for canoes bound west. The extremity of the point is of the same character of rock, but the change from the talcose (?) to mica slate or schist is very gradual and imperceptible, the colors and characters blending and mixing apparently in the same rock. At the same time the quartz interlaminations and deposits of the talcose (?) slates, mined for gold, become syenite in the mica schists (with fewer quartz veins).

Further north, perhaps a mile, the syenite runs both obliquely across the schists, in sharply defined veins, and also nearly coincident with them. In one case a belt curves round from one system to the other. There is also in the schists a net work of harder, more quartzose rock, which crosses itself both finely and coarsely, and becomes evident on the weathering of the formation along the water line. The schists here also contain fine crystals of pyrite.

404. About a mile and a half further northwest, up a deep bay, is a ridge of granite, massive and jointed, not laminated or schistose. This is on a point of the N. shore.

405. A few rods further a ridge of this rock appears. This is firm mica schist, with reticulations and interlaminations of gray quartzite and quartz, and also cross layers and interlaminations of syenite. In the main the syenite is coincident with the schistose structure. In this locality are many islands, made up apparantly of rock like No. 405, north of which is a large bay running far west. North from the last point on the north side of this bay, the mica schists again are seen, of the same kind as the last, but the structure and laminations all dip to the north (a trifle east) at an angle of about 30° from the horizon.

406. Mica schist from the north side of this long bay (as above noted) with included gneiss, on the north shore of Vermilion lake.

407. A micaceous quartz, from near the same point.

This coast is bold and more rocky, running NE. The dip and character of the last continue northeastward past several points, the rock becoming more granitoid.

408. Fairly represents the whole of the exposure, a confused granitoid rock, with patches of mica schist.

409. Granite. On the next little point, which encloses (on the E.) a deep, narrow bay running N. to the outlet of Vermilion L. is an exposure of gneiss which passes confusedly to granite and to mica schist, but has no schistose structure. It appears as if a very coarse conglomerate might have been brecciated and then metamorphosed. There are small patches of mica schist surrounded by gneiss, and bands of coarse granite running through the whole varying to a fine granite, and so to a micaceous quartzyte. It is smooth, massive and bare.

410. Granite; same place as No. 409—pinkish.

411. Granite; same place as No. 409—pinkish.

412. Mica schist; same place as No. 409.

413. Mica schist, from the Vermilion rapids, at the outlet of Vermilion Lake northward.

At the outlet, which leaves the lake northwardly, and which seems to be in the northwestern part of the lake, the water goes down about 50 feet, with considerable tumult, over large boulders of coarse granite, without much exposing the underlying rock *in situ* along the river. But by the freshness of slabs of mica schist, and their size, it may be inferred that the rock under the rapids is No. 413, and on the east side of the bay from which the river goes the same rock as No. 413 can be seen *in situ*.

Eastward from the Outlet bay the rock soon appears, and is a coarse granite, viz:

414. Granite, with a little mica schist in spots.

415. Mica schist, embraced in No. 414; north shore of Vermilion Lake. The same (granite and mica schist) continue round the deep bay running east, and along the south shore of the same, so far as the few exposures allow a judgment to be formed, and on the point where the shore finally turns south again, the rock is also mica schist, enclosing patches of coarsely crystalline granite, the whole dipping N.

416. Mica schist, from long point on the N. shore of Vermilion Lake, east of the outlet; varying to

417. Micaceous quartzyte.

This long broad point, which extends southwardly, leads to the location of No. 404 and No. 405. The mica schist, with associated granite (or No. 404) occupies the N. shore all the way round. It is not yet possible to say whether these granite and syenite areas are embraced in the Huronian or indicate a conformable approach to the Laurentian.

418. At about a mile S. E. from the location of No. 404 and No. 405, on the north shore of the lake, but on the south shore of this long broad point, on the N. side of a bay, is seen this fine granite, and

419. Micaceous quartzyte. These are about equally divided in making a rocky point, and have a schistose structure running S. 15° W., nearly vertical. The point is high, firm and bare, the schist being knit by reticulations of harder quartzyte, and by bands of granite, so as to resist disintegration.

There are several other outcrops of similar rocks on this long point, as far as to and beyond a long bay running S. W. This bay along the south coast is rocky, and is made up of mica schist with reticulations; but it is softer, finer and apparently approximating a talcose (?) character. Glaciation here runs S. 30° W. and the slates run in about the same direction; represented by

420. Soft mica schist.

421. As this "north shore" begins to turn east, the coast is high and rocky. This is after passing the narrow canoe passage mentioned under No. 403, and S. E. from Simond's location about a mile. There is a prominent system of joints dipping N. and not an evident schistose structure. The veins and joints are either white quartz (some has been worked slightly) or are quartzitic. The reticulations mentioned as seen in the mica schist are much less distinct, or are wanting. The rock is

422. A talcose (?) quartzyte.

Three-fourths of a mile further east this rock, No. 422, shows a schistose structure running W. S. W. and sloping to the south (or S. E.) The slabs, sliding off according to the joints, hide from first view this structure, and also make the immediate shore precipitous.

423. Ore from Nobles' mining location; Vermilion Lake. This is about a mile N. W. from the Minnesota Company's location, and on the south side of a long point extending S. E. from the west shore, and on the north side of the included bay. The rock is a chloritic (or talcose) (?) slate, varying to a greenish schistose quartzyte. It has pyrite crystals scattered through one or two narrow quartz veins (each 1 to 4 inches) and also through much of the siliceous rock itself. The frame of their mill still stands, and two large reverberatory furnaces, amid the ruins of other ma-

chinery. The stamps were five, made in Chicago. In this mill much of the country rock was crushed as well as the quartz.

424. Chloritic schist; from a little west of the Minnesota Co.'s location. The structure here runs W. S. W. and slopes a little north. Also at other points between this point and Nobles' the structure slopes N. This number is only a local variation in the prevailing slates of the region, extending only about 6 feet.

425. Pyritiferous granulyte, (quartz and feldspar) and blue scales from some of its joints. This rock forms a low island in a large bay west of the Government's Station, or that principal part of Vermilion Lake which is next west of the Station, and is shut in on the north by a long promontory-like point with drift boulders and sand on the immediate coast, along the S. E. side. The island is near the head of this bay, about two miles from the station. The rock is jointed and somewhat schistose coarsely, in about the same direction as the slates here, and slopes N. It seems to be a part of the slate formation: but there is not sufficient exposure south and east of this point to make it certain.

426. The rock of Ely Island or its variations. Much of it is like No. 311 and No. 375, perhaps the greater part. It is mostly of a light color, often with a light green tint, having free quartz in a matrix generally amorphous but yet presenting a fibrous or broken schistose texture; passing to a porphyritic rock (with albite crystals) (?) and to a pyritiferous syenite. On the north side of Ely Island is to be seen a conspicuous white quartz lead, or vein, about thirty inches thick, sloping about 55° from the horizon to the north, distant from the west end of the island about a mile. It rises so as to make one of the highest parts of the island. Some working for gold has been done on this quartz, near the lake. The quartz itself is barren, but the adjoining rock is pyritiferous, like nearly all the rock about. It has a structure dipping north, the same as the lead of quartz, and is jointed in all directions.

On the north slope of Ely Island glaciation shows S. 8° W., and on the top of the island it is very coarse and in the same direction.

In traveling over the island, where much of the rock is bare, occasionally may be noticed bright red pieces of jasper superficially embraced in the formation, some of them three or four inches across. The position and structure of these pieces is at variance with the schistose structure of the rock in which they are embraced. They at once recall the "gunflint beds," which at Gunflint Lake first overlie a similar greenish and magnesian formation, having a slaty and a schistose structure like that seen here. These pieces seem here to be relics of that formation, which once must have extended over Ely Island, but now is unknown about the immediate shores of Vermilion Lake. The quartzyte (and gunflint series) underlying the lowest igneous overflow of that age, was probably so thin that the heat so softened the underlying (Huronian?) schists that some of the more siliceous and less fusible parts of the gunflint beds were cemented into the schistose, and after the erosions of the glacial epoch they still are seen so embraced. This heat produced a second metamorphoism of the magnesian formation also, changing it locally, apparently, to a phonolitic, or porphyritic, partially crystalline rock. Some of these relics, still attached, are conglomeritic; and one area, which is embraced in a depression in the upper surface of the schists, is over two feet long and eight inches wide. Loose pieces, pertaining to the drift, may be seen on the top of the island, being of black quartzyte, showing that the quartzyte formation must have extended once to Ely Island at least, since the movement of the drift was from the N. and E. of N. It may also have extended further north, and probably did, at some pre-glacial time. These jaspery pieces, generally smaller than a butternut, but sometimes as large as one's fist, are nearly always angular, or but little rounded, and are in some portions thickly sprinkled over the surface of the schists.

There is a high hill-range to the south of Vermilion Lake, about a mile and a half from the shore, which may be the beginning of the trap and quartzyte range again. That would be in conformity with the foregoing hypothesis. Indeed these hills appear to be of some rock different from the rock along the south shore of Vermilion Lake, as they do not appear white at a distance, like the immediate shore of the lake, though the timber is wholly burnt from both.

427. Rock of Ely Island, containing jaspery pieces.

428. Pyritiferous quartzyte, from Rison's place, Ely Island.

Passing about a mile up a river running into the south part of Vermilion Lake from the east, about two miles from the entrance of Pike river, being the easterly of two rivers that enter the lake near together, and then traveling by a blind trail about ¾ mile toward Vermilion Lake, we reach an old iron-working, said to have been done by Stuntz and Mallmann, under the direction of Prof. A. N. Chester in 1872. This iron is in what has been denominated in these notes the *Gunflint beds*. It is in conformable arrangement with the magnesian schists and slates. Indeed the

Gunflint series here presents a good exposure. It stands in laminations and schistose bands nearly vertical, and is only a modified superficial condition of the underlying schists. These beds pass downward into the schists, and in places the schists and the schistose structure penetrate upward into the jasper and iron. The jasper and iron are in some places replaced by bands of white quartz. Here are all the beautiful variations between jasper and hæmatite, banded together, and quartz, which can be seen at Marquette.* Although the structure of these beds here seems to make them conformable with the underlying slates and schists, yet it may be this structure is only that superinduced on them at the same time that the schistose structure was formed in the schists, the original bedding (which may have been nearly horizontal) having been obliterated by the change. In the same manner, or in a similar manner, the bedding of the same formation has been seen to be destroyed by contact with metamorphosing agencies, as at places on Pigeon Point, and a very different aspect given to the formation. Further observation of this horizon is necessary to settle this question of conformability between these two formations. There are several knolls of the schists in this vicinity, capped with this iron and jasper. They run in the usual direction, a little south of west, and seem to be very persistent under glaciation, as they would naturally be. The belt must run northeastward toward Gunflint Lake, and is here, apparently, about a mile wide. The greatest thickness seen here is about 25 feet. There are gradations in the coloring of the qnartz nodules in this rock, some being gray, and some uncolored, while others are nearly black, and some vermilion red and jasper red. The name of the lake is supposed to have been derived from these colored pebbles.

429. Hæmatite from Vermilion Lake, as above.

430. Conditions of the silica from the same place.

About the southwest shores of Vermilion Lake, which expands right and left in broad sheets of water and in bays, that have a direction according to the trend of the geological structure, much more than is shown on any maps yet published; there is much drift, some of the points and narrow land-lines being of stratified sand, while along the coast in general can be seen only boulders.

Opposite Winston, the town site laid out by Maj. T. M. Newson, there is a firm gray quartzyte in outcrop. Several other small exposures of a laminated quartzyte, with a structure parallel with the slates of the country, occur before reaching the entrance to Pike river.

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*Boulders of the greenish schists occur on the south shore of Vermilion Lake, with bands of jasper running through them at least three feet from any outer surface.

431. Rock that forms the first rapids of Pike river; three feet of gray, firm fine-grained, heavy crystalline rock, similar to some of the beds of the quartzyte and slate formation.

At the main rapids of Pike river, where the first portage occurs, there is a tumbling fall of six or eight feet, making a good water-power. This is about ½ mile from the bay where the river enters, and here is a considerable exposure of rock, on each side of the river.

432. In general a gray quartzyte, but varying to a syenitic rock, and to a siliceous slate, and to white quartz, as well as to a tremolitic (?) mica schist, which is dark gray. It exhibits small faults, in which the otherwise parallel and regular strata, or laminations, are jagged or twisted, the west end moving southwardly about 5 inches or less. This rock, except in its perpendicular arrangement, and the absence of trap, resembles the gray quartzyte formation of Pigeon Point. It is more highly tilted, and generally metamorphic. The beds are nearly perpendicular, but dip to the south. If this be in the strike of the gray quartzyte and slate, the Vermilion iron-ore belt must pass north of here, running below the south arm of Vermilion Lake, or perhaps crossing Pike river north of the rapids. The structure of these beds is parallel with that seen at the iron beds at the location southeast of Vermilion Lake. Glaciation above the rapids is N. and S.

The river above the falls and rapids is 923 feet above Vermilion Lake, by aneroid, and above the third rapids is 938 feet, where the glaciation was S. 10° W. The rock at these third rapids is of the same gray quartzyte formation, the strata running E. and W., and dipping S. at an angle of about 60°. On another knoll the structure runs W. 25° N. This is also true just at the upper landing; in other places it is lost, the rock becoming massive, but having then a coarser grain. Where the structure is W. 25° N. the beds stand more nearly vertical. At a point on the left side, about a mile above the last portage, and before reaching the fourth rapids, there is an outcrop and a covered ridge of quartzyte, the beds of which are about 10° out of perpendicular, and dip to the north. Their edges run W. 5° N.

Two other rapids in Pike river, passed without portage, show no rock *in situ*, the water rolling over boulders, but at the first there is no doubt that the quartzyte from the ridge and outcrop last described closely underlies. A short portage is then soon made, at the crossing of the "Vermilion road," the rapids here being styled "Devils gate rapids." Here also are only boulders, but from the size and frequency of large quartzyte masses, that rock is judged to be still underneath.

At a point judged to be about five miles from Vermilion Lake occurs a low irregular outcrop on the right bank of the river, represented by

433. A fine-grained reddish gneiss. This does not show certainly the direction of "bearing," but by its generally up and down fracture it seems to be allied to the quartzyte formation, as well as by its composition, the quartzyte formation sometimes passing into gneiss. This is highly inclined.

About 3 miles further begins a portage across a cranberry marsh about a mile over. The trail is covered with about two inches of water, and the river is but little lower.

The summit portage which leads to a stream flowing south (the Embarras) is over three miles long. It is a difficult portage, going over alternating sandy plains of Norway pine and wet tamarack or ericaceous bogs. In the swamps are laid small poles and sticks, which, if a person does not slip from, keep his feet out of the water and mud, but which from their insecurity to booted feet prove a great aggravation. It is mainly a flat country with a gradual descent to the south and occasional steps downward from plain to plain, the steps being boulder-strewn. There are also kames of gravel and sand. From the abundance of granite boulders, it is probable that the entire distance, from where the trail leaves Pike river to the Embarras, is occupied by one of the Laurentian belts, indicated also by the reverse dip seen at several points on the Pike river. It is really the Mesabi, or divide between streams flowing N. and S. though the great range is about two miles further south. At about a mile from the north end of this long portage, (which is drift-covered and generally dry to this point) occurs a dome of moutonne-ed syenite, viz.:

434. Syenite, with some of the feldspar flesh-colored, and some of it white. This is on the right of the trail, and spreads several rods round, rising 6 or [illegible]0 feet. This is about ¼ mile north of where the famed "Mesabi Hights" first appear in traveling south. From the north the "Hights" have an irregular contour, not like the quartzyte and trap range along the Boundary and Mountain and Rove lakes, but more like a great drift moraine. They rise several

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*In passing this summit portage the shrub *Sweet Fern* is seen growing abundantly, on a gravel ridge or "kame".

hundred feet above the surrounding country. They may be superficially of drift, but probably their location, hight and composition are largely made by rocky barriers.*

The Embarras river is lake-like, for ¾ mile: then rapids, and ¾ mile portage, the descent being 64 feet, to a lake. Throughout this portage there is no rock *in situ*—only Laurentian boulders can be seen, and they are very numerous. The same is true along the river, except at one point where there is a visible bare rock, on the right bank of the same sort as the boulders, which is probably in place, viz:

435. A Laurentian syenite, like the rock No. 305, at the east end of Gunflint Lake, lying near the line of strike of the quartzyte and slate formation. This forms here the lower reaches of the Mesabi. The range seems to be of drift.

Along the east side of the next lake is high land, but no rock can be seen. About a mile from the north end of this lake is a high knoll on the west side of the lake, but there is no sign of rock. The whole country is deeply drifted. This feature steadily increases in going south after leaving the south end of Vermilion Lake. The course of travel seems to be mainly in the line of the great central glacier of this part of the State. The Embarras river here passes through one of its lateral moraines. This lake is about 5 miles long and averages ½ mile wide. At the foot of this lake is the "Squagemaw Bridge" where the Vermilion road from Duluth crosses the river.* This bridge is about on section 5, T. 58, 15.

From Squagemaw Bridge to Little Falls.

High land extends indefinitely, in the form of hills, along the west side of the Embarras river, southwestwardly from the Squagemaw bridge (Sec. 8, T. 58, 15). These hills seem to be made of drift, lying here on the Laurentian (No. 435), without apparent conformity or parallelism with any rock-range, the river crossing the drift-range about a mile above the bridge.

The road to the Mesabi iron location passes eastwardly from the bridge, through the northern tier of sections of T. 58, 15, revealing a very fine, level (burnt) tract of farming land, underlain by a coppercolored drift-clay. In section 31, of T. 59, 14, the drift clay is seen to contain a great many pieces of jaspery and quartzitic rock from the gunflint beds. On Sec. 28, of the same town, near the center of the section, some surface work has been done to develop the iron of this region. Some shallow pits have been sunk and one east and west trench dug, but none of these works seem to have reached the bed-rock. The drift here consists almost entirely of debris of the quartzyte and gunflint beds. Some pieces of pretty good hæmatite are also mixed with this debris. Near the section line between 15 and 14 is another pit, sunk alongside the faulted rock of the gunflint beds, the face of the bluff appearing above the ground and looking S. E. (A). The face then swings round so as to look south. The compass is exactly reversed by the proximity of magnetic oxide, glaciation being estimated at 20° W. of S. The ore here is closely associated with the rock, and they run together, and blend.

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*Squagemaw means "last lake," and the word applies to the second lake below this.

Almost due west from the foregoing, distant about half a mile, are several other trial pits, intended to show the trend and surface characters of the layers containing the iron, (B). Here the face of the break looks north, and the beds dip a little toward the south. The rock rises to the surface, and the needle is useless. The layers are about 3 or 4 inches thick, differing from (A), where the rock is massive or in heavy layers. Here seems to be a large amount of good iron, but it cannot be stated how far these characters extend without elaborate magnetic observations. The formation is the great quartzyte, probably near the bottom.

Along the road further northwest is another working (C), which is near the road, and marked by a high ridge of the iron-bearing rock running E. and W., and dipping nearly N. The upper part of this exposure is hardened and massive, and black. This is about 5 feet thick, as seen in the pit, and under it is a thickness of about 5 feet more of a loose limonitic mass. This is a conspicuous irony ridge, but its effect on the needle is not so great as at (A) and (B).

436. Ore from the Mesabi iron range, shaft (A.)

437. Associated rock at (A.) This is charged with siderite, and even becomes changed to siderite, as at Gunflint Lake.

438. Ore from the Mesabi iron range; shaft (B).

439. Rock associated; similar to No. 437.

440. Ore from the Mesabi iron range, shaft (C), near the bottom; somewhat limonitic and carbonated.

441. From the same shaft near the top.

About half a mile south of the last is a shallow pit dug for silver. This is in the gray quartzyte. The country rock is somewhat banded with iron.

442. Rock of the country: from the Mesabi iron range, from a shaft sunk for silver.

On this range of high land are considerable tracts of hard wood, with only scattering pines. The large trees are gray birch, elm, sugar maple, white birch, black ash. The white pine and white cedar creep in slowly along damp spots or slopes, and some large tracts are principally covered with pine, the trees being some of the largest seen in the State.

Other trial pits for iron were sunk in 1874 in T. 60 N. said to have promised even better than the foregoing in town 59.

Between the second and third lakes of Embarras River there is a rapid, and a descent of about 15 feet, making it necessary to portage about 20 rods. This makes a fine water-power, and is well situated for a lumber mill. No bed-rock is visible—only boulders.

The country has but little grown timber, what there is being scattered Norway pine. The whole surface for many miles in all directions appears to have been devastated several times by fire during the last 15 years. Hence there is a small growth of aspen almost everywhere, varying in age from one to a dozen years. This lake is small, and the river goes by a similar rapid into the 4th lake of Embarras River, with a descent of about 8 feet in 10 rods. This lake is separated by narrows like a river into two parts, and finally passes into the real Squagemaw Lake (last lake) at the head of which is a sandy beach, the portage to which is about 30 rods. This lake is larger than either of the last two. Below this lake the river has a considerable volume and current, and often sandy banks, the country also being flat and sandy, with generally small timber, mixed pine and hardwood, but many aspens and birches.

White oak was first seen at Squagemaw Lake. There is no bur oak in this country, so far as can be seen in traveling this route, but various maples, ash and elm are common, also bass. The balm of gilead is not a common tree. It seems to prefer the lake shores. The land is generally dry (to town 56, 17), at least so far as can be seen from the river, with occasionally an exposure of drift-clay, affording small stones. The rapids along the stream show only bowlders, there being apparently a heavy deposit of copper-colored drift-clay over which the river runs.

Passing down the St. Louis river to the mouth of the Big Whiteface river, the drift, which everywhere is thick and hides the rock from sight, can be summarized, so far as seen along the river, in three parts: 1. Red gravelly clay, or "pebbly clay." 2. Laminated gray clay. 3. Red stony clay, the last being at the bottom.

There is but little change in the features of the country, from Squagemaw bridge to the mouth of the Savannah river. It is all arable and habitable land, and is destined to be filled with an agricultural population. There are vast tracts on the St. Louis, above the mouth of Big Whiteface that are burnt, but seem to have been generally more sandy than clayey, and are flat, the level being about 30 feet above the river. At some points above there is a heavy red-clay drift, and the banks are about 40 feet above the river. At the Big Whiteface the banks are about 20 feet above the river, and the adjacent country is flat. The Savannah river drains a flat country, underlain by clay (which at its mouth is red and horizontally stratified), and each tributary is skirted by a grassy border on each side, which, further up, becomes a tamerack swamp, but nearer the main river is enclosed by aspen, on flat ground but little above the river. The region of the Savannah river is generally timbered, mainly with aspen, somewhat with white oak and white pine and spruce, and an occasional tree of balm of Gilead. The old portage trail from the St. Louis to the Mississippi river, by way of the Savannah river, is now abandoned and obliterated. It is superseded by another 7 miles long, which leaves the St. Louis about on Sec. 27, T. 51. 20, about ¾ mile below the large island represented on the surveyor's township plats. This leads to Prairie Lake, and thence through Prairie river (when not too low), reaches Sandy Lake and the Mississippi. The country through which the portage passes is generally dry, but it passes through one cranberry swamp at about six miles from the St. Louis. The portage trail also lies on a glacial kame for some distance, at about 3¾ miles from St. Louis river. The country is not generally flat, but often undulating or even hilly, especially between three and four miles from the St. Louis. The kame mentioned runs some south of west, and has swampy tracts on the north and south sides. At 5 miles the drift was seen to be red clay, with pebbles.

The trees to be seen on this portage consist of the following, about in the order named for frequency: Aspen, white pine, white birch, balsam, tamarack, white spruce, Norway pine, soft maple, sugar maple, white cedar, ironwood, elm, ash (white and black), blue beech, black and bur oak, small red cherry (sometimes six or eight inches in diameter), bass, gray birch (small trees). There is much doubt whether the true black spruce grows in this

State, or in the northwest—such as seen in Maine and used there for lumber. Ours seems to be all white spruce, and rarely becomes large enough for boards, although it does sometimes. Mr. Lapham names hemlock as one of the trees of Minnesota, but it has never been seen by this survey, nor can any one be found who can name a locality where it grows in the State.

The level of Prairie Lake is about 135 feet above that of the St. Louis River where the portage leaves it, according to a series of Aneroid observations in an unfavorable state of the weather.

Prairie River being too low for canoes, a portage of 16 miles is still necessary to the shore of Sandy Lake. This portage discloses no rock, but passes through a good drift-covered, agricultural country, flat to undulating. all timbered, formerly with much good pine. The western part of the portage, however, passes through considerable tamarack swamp. The swamp occurs before crossing the W. Savannah River. On the west side of that river (which is a tributary of the Prairie River) the land is dry and sandy, with small Norway pines. The shores of Sandy Lake are of sand, with only occasional points of gravel, or small boulders. On reaching the Mississippi River, the drift is seen to be *gray hardpan*, thus contrasting with the drift seen on the St. Louis, and on the portage trail to Prairie Lake. At four miles above Aitkin it is also gray and of the later drift epoch. The flood plain is 14 ft. above the river generally, but occasionally new flood plains, now making, are from 5 feet (or from zero) to 14 feet high. The new plains generally rise to the level of the old plain at their up-stream ends, where the two unite in one, the former gradually taking the place of the latter with an imperceptible diminution of height. This new plain sometimes extends, on one or both sides, for half a mile, or a mile, making it appear as if the real flood plain were but six or eight feet above the river. Suddenly a higher plain strikes in from the country in traveling down the river, and by a single step the level is as before about 14 feet. Of course the river has all stages between the level of very low water and some feet above this 14 feet flood plain, since there are water marks on the trees considerably higher than 14 feet. At a point a short distance below Sandy Lake is a sandy and timbered bluff about 25 feet high, having Norway pines, but with that exception there is no land between Sandy Lake and Aitkin visible along the river higher than this 14 ft. flood plain. The material of the flood plain is generally a horizontally stratified fine clay, varying to a fine sand, but the laminations are sometimes oblique near the water level, and on the top sometimes the material is rather sand than clay. This flood plain is heavily timbered with elm, white oak, soft maple. These three make up more than ¾ of all the trees; but there are also white birch, aspen, bass, black ash, white ash, gray birch, sugar maple, willow and among the conifers a sprinkling of white pine, balsam, spruce, tamarack (and one tree of white cedar.)

Between the river and the village of Aitken, a distance of one mile, the country generally is not much higher than the above-mentioned flood-plain, and rises imperceptibly from the river to the railroad, about five feet, the alluvium being replaced superficially by a gray hardpan, with boulders on the surface, the timber being also much the same.

At about 15 miles below Aitkin appear unmistakable traces of a permanent higher flat, where it approaches the river and has been cut off like a terrace-step by the action of the current. It is two to four feet higher than the flood-plain, but even then still appears to taper down stream to the level of the real flood-plain. In descending further this higher flat becomes more and more marked and persistent, the river itself also having apparently a lower flood-plain than before, so that the real difference in hight between the two plains is about 14 feet. This upper flat where it approaches the river, is markedly different from the lower flat which accompanies the river nearly all the way. It has small timber, and a few scattering pines, with occasionally a clump of balsam or spruce, or is a devastated burnt plain, while the lower flat is timbered heavily with large trees of elm, oak, ash, and basswood, and is rarely invaded by fire. The upper flat is also very different from the lower in composition. For the most part it is a stony or pebbly drift clay, from the river upward (in one case seen to be a "pebbly clay" for 20 feet) with a rusty or yellowish sand on the top, though in some spots the sand is almost wanting--but the lower flat is a fine alluvium, generally a laminated clay.

Further down the river, as at the mouth of Pine river, this upper flat is unusually elevated, being about 80 feet above the flood-plain: while at points above it is seen to gradually increase in hight in descending the river, the most common elevation being 40 or 50 feet above the flood-plain. The same change is to be seen at and above Pine river as already noted. A lower flood-plain is seen to rise within the real flood-plain, at its upper end being nearly of the hight of the 14 ft. flat, and at its lower to gradually become less and less till it sinks to the level of the water. The highest flat has Bank's pine at Pine river, and at some distance above. The high banks, where favorably exposed by slides, are seen to be composed of gray clay, generally pebbly, but usually with boulders in the river adjacent. This clay is covered with a varying thickness of yellow stratified sand. The clay has some limestone, as from Winnipeg.

But below the mouth of Pine river, about one mile and a half, a red clay is exposed in a number of places, in cuts in the high banks of the river. This is stony and sandy, and is the probable source of the rusty sand seen to be lying over the gray clay already mentioned. Still further down, this red clay is seen overlain by much rusty sand. As a rolling or undulating surface gradually comes on, the cuts are generally of this sand, or stones and sand with little clay, the river running faster and having a flood-plain of only six or eight feet hight. The gray color is still seen in low plains or flats lying between the red knolls, but, generally speaking, a change from gray drift clay to red takes place at the mouth of Pine river.

At the French Rapids, a short dirtance above Brainard, is a high and rolling tract of red drift which furnishes the boulders of the rapids. These hills rise 100 feet above the river just above the rapids.

Below Brainerd the country is very sandy and undulating, and the flood-plain seems to be almost wanting. The timber is mostly of Bank's pine. About Crow Wing there is less sand, but abundance of little stones and of gravel, and the banks are only 8-10 feet high, with rapid current and almost no floodp-lain. Higher drift banks are visible in the distance, east and west. Below the French Rapids the real "red clay" is not seen for some distance, at least to Fort Ripley, but in its place can be seen yellow sand and red sand, and almost clean sand, and below this a stony gray clay, or only stony slopes to the water. But as red clay the drift appears only where mentioned, at and below the mouth of Pine river to the French Rapids.

Olmstead's Bar is a long shoal, about two miles below Fort Ripley, and the flood plain is low. No bedrock is visible—only stones from the drift. Prairie Rapids are near Belle Prairie, and are similar to Olmstead's Bar. At Belle Prairie the flat sets in on which is Little Falls, though it really begins some miles above, although further north it is undulating, and can hardly be styled a continuous flat to Brainerd. It still seems to have been once the flood-plain of the river, in the same manner as at Little Falls. It is probable that then, as now, the river had a swifter current above Belle Prairie, and left on this plain a sandy sediment, and a surface more susceptible to change by wind, and less adapted to vegetation, circumstances which have tended to bring about a moderately broken surface. It is probable that an ancient morainic belt is crossed by the Mississippi between Pine river and French rapids.

III.

PALÆONTOLOGY.

New Brachipoda from the Trenton and Hudson River formations in Minnesota,

BY N. H. WINCHELL.

ORTHIS WHITFIELDI (N. sp.)

Shell semi-oval, the hinge-line being a little less than, or equal to the greatest transverse diameter, the cardinal angles being a little greater than 90 degrees, the edge passing in a regular semi-oval curve through the antero-lateral angles, but sometimes with a very slight inclination in front toward the side of the receiving valve. Size varying from 9½ to 14 lines in transverse diameter, and from 8 to 11½ lines in perpendicular diameter, in the large size the convexity being, between the umboes, 6½ lines.

The receiving valve has a distinct and full beak and umbo, from which the surface slopes evenly to the margin all round, but having a little flatness at the cardinal angles. The cardinal area is arched, and at its union with the cardinal area of the entering valve forms an angle with it of nearly 90 degrees; its hight is about 1-6 its length; its foramen is triangular and reaches the beak, the width across the base being somewhat less than the hight; plications of the surface are strong, direct and simple, but double their number on the umbo by implantation, and again in the same way* before reaching the margin, where they number from 36 to 48. Between the *plicae* are fine cross-ridges which sometimes rise to the tops of the *plicae*, but do not cross them so as to be preserved

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***By implantation is meant that method of increase which is seen in the rise of intermediate folds in the surface of the shell between the older *plicae*, whether the new fold be in the middle, between the others, or is seen first to be nearer one than the other of the older folds, there being no change in the size nor direction of the larger folds. Bifurcation signifies a nearly equal division of the larger folds which at first lessens their size and changes their direction.**

in our specimens. A cast of the interior of this valve shows a distinct general muscular impression, reaching a little more than one-third the perpendicular diameter of the valve from the beak, and divided longitudinally into shallow furrows and ridges converging within the beak, four of the former and five of the latter, with a cross-striation visible on that portion between the teeth and near the foramen. The central ridge in the general muscular impression on the cast, does not reach the front margin of the scar, but gradually dies out, giving place to the adjoining parallel furrows which widen and coalesce, and show a longitudinal finer furrowing or striation. The next ridges, on either side, are marked and prominent, extending to the anterior angles of the scar, giving it a nearly straight, elevated front and angular corners, somewhat as in *O. subquadrata.* The two outermost ridges are fainter, but extend to the lateral margins of the scar. Still outside of all these ridges are traces of a similar furrowing within the beak, embracing that portion between the teeth which has the fine cross-striation. The outward plications of the valve are strongly marked on the cast for about 2½ lines from the margin, and some of them run faintly even to the edge of the muscular scar.

The entering valve is much less convex, but cannot be said to be flat, though it has a faint flattening along the center, which widens to the front margin where it is changed, in the large specimen, to a slight concavity and produces a straightening, and also a very slight flexure, of the margin. In front of the cardinal angles also, on either side, is a flat or depressed area; cardinal angle parallel with the posterior margins of the valve, and a little more than one half the hight of that of the receiving valve; beak indistinct; foramen triangular and about as wide as high, with a small central, smooth tooth which does not rise above the plain of the area, and only becomes visible on being cleaned and excavated. A cast of the interior of this valve shows marked internal characters. While the impressions of the individual diviricator and adductor muscles on the same side are not separable with certainty, owing to the faintness of the lines between them, the pairs of each are divided, on the cast, by a deep, sharp furrow that extends from the beak where it divides the divaricately striated cardinal process into two equal lobes, toward the front between the depressions of the hinge-teeth, to a point somewhat more than ⅓ the diameter from the beak, when it dies away, or runs into a broad, abrupt, medial depression which produces the flatness in the valve extending to the front margin. The external *costae* are deeply impressed on the cast about the margin, some of the lines running faintly within the vascular area. The exterior of this valve is also marked by concentric fine striations, especially between the *costae*.

This species resembles Meek's description of *O. fissicosta*, H. more than any other, but in that the valves are nearly equally convex, the receiving valve has an abruptly pointed beak and a narrow foramen, and the external *costae* are 19 or 20; the interior of the dorsal valve has no "defined muscular scars so far as known" (Meek), the muscular scar of the receiving valve has an oval-subtrigonal outline, with two linear ridges that do not continue round the front; and the size of the shell is much less than this, our smallest specimen being two lines wider than the largest ever mentioned of that species.

Named in honor of R. P. Whitfield of New York.

Formation and Locality. In the Galena beds of the Hudson river formation, at Spring Valley in Fillmore county.

Museum Register Numbers 277 and 429.

Collector, N. H. Winchell.

ORTHIS SWEENEYI (N. sp.)

Shell suborbicular, with a straightening along the hinge-line, and having the general aspect of *Orthis pectinella*, but with a shorter hinge-line.

The receiving valve is convex, with flattened lateral marginal areas and cardinal angles; *costae* coarse and simple, numbering about 22, all of which continue to the beak except two or three on each side, which in passing from the margins in front of the cardinal angles, rather terminate on the hinge-area. The *costae* and the furrows, which have about the same width, are crossed by fine, crowded, concentric *striae;* beak distinct, but not much elevated above the margin of the area; area slightly arched, but directed in the plane of the edges of the valves; area triangular, equilateral, containing a simple tooth which rises to the apex but is not developed so as to appear in the plane of the cardinal area, but is horizontally ribbed on either side. Interior unknown.

The entering valve is flat, with a little elevation at the beak and umbo, and a broad slight concavity between the umbonal region and the front margin; *costae* the same as on the convex valve; beak small and more abrubt than that of the other valve; area low and flat, but of nearly the same hight as that of the other valve, with which it forms an angle of about 45 degrees; foramen partially closed, but open below, broadly triangular.

The transverse diameter is seven lines in the single specimen belonging to the survey, and the perpendicular is six.

This species in general aspect greatly resembles *O. pictinella* of Conrad, but is essentially different, in that the foramen and area are on the flat valve instead of the convex one, the perpendicular diameter compares to the transverse as 9 to 12 instead of 6 to 7, the cardinal line is extended so as to equal, or nearly equal, the transverse diameter, and no mention has been made of the existence in that of a cardinal tooth in the foramen of the convex valve.

Named from Dr. R. O. Sweeney, of St. Paul.

Formation and Locality, in the lower part of the Hudson river Shades, at St. Paul.

Collector, N. H. Winchell.

Museum Register Number, 3,520.

GENUS STROPHOMENA (*Rafinesque, 1825.*)

(Manuel de Malacologie, of Blainville.)

Under *Orthisidal* Mr. McCoy has included (1855, *Bret. Pal. Foss.*) 1, *Porambonites*, 2, *Orthis*, 3 *Orthisina*, 4 *Leptæna*, 5 *Strophomena*, 6 *Leptagonia*, and 7 *Chonetes*, but under *Leptæna* he places *Leptæna*, "*restricted*," *Strophomena*, Rof. *Leptagonia*, McCoy, and *Chonetes*, Fisch, as subgenera, with the following distinctions, viz.:

1. *Leptæna* of Dalman, restricted to the type of his last species (*L. transversalis*), in which the valves are almost equally curved in the same direction, the receiving, or foraminated one, convex, the other concave outwardly.

2. *Strophomena*, in which the valves are flat or very slightly convex when young, the margin in a few species becoming, by age, deflected, usually toward the receiving valve, as in *S. rugosa* (Rof.)—resupinate species.

3. *Leptagonia* (McCoy), with both valves abruptly bent at right angles toward the entering valve, and the rosteal portion concentrically wrinkled.

4. *Chonetes* (Fisher), only different from Leptæna (as restricted) by having a row of spines on the hinge-line, thus approaching *Productus*.

By this classification most of his species fall under *Leptæna*.

Mr. Billings, in 1860,* makes two groups of the Genus *Stophomena*, taking *S. alternata*, of Conrad, as the type of one, and *S. filitexta*, of Hall, as the type of the other. Of these the former has the entering (dorsal) valve concave, or sometimes nearly flat, and includes the species *alternata* (Con.), *deltoidea* (Con.), *camerata* (Con.), *tenuistriata* (Sow.), *incrassata* (Hall), *nitens* (Bill.), *Ceres* (Bill.), *Leda* (Bill.), *Philomela* (Bill.), *imbrex* (Pan.), and *rhomboidalis* (Wilck), and perhaps others. The latter group contains the resupinate forms which have a concave receiving valve, viz: *filitexta*, (Hall), *fluctuosa* (Bill.), *recta* (Con.), *planoconvexa* (Hall), *antiquata* (Sow.), *planumbona* (Hall), and *subtenta* (Con.)

At the same time Mr. Billings retains under *Leptæna*, the species *decipiens* (Bill.), and *sordida* (Bill.), as well as *sericea* (Sow.), without specifying what difference he relies on to distinguish *Leptæna* from *Stophomena*.

Mr. Meek has maintained the genus *Leptæna* by describing and figuring *L. sericea* (Sow.) in the First Volume of the Palaeontology of Ohio, and divides the genus *Strophomena* into two parts, one of which represented by *S. rhomboidalis*, Wilckens, is taken as the type of the genus, and is the equivalent of the *alternata* group of Billings, and includes both the restricted *Leptæna* and the *Leptagonia* groups of McCoy. The resupinate species he distinguishes by placing them together under the sub-genus *Hemipronites*.

The conflict which exists between these two generic names (*Strophomena* and *Leptæna*) seems to have arisen from two causes. 1st, their nearly synchronous adoption and use in different countries, and 2nd, the very general and incomplete definitions by which they were made known. Dalman's genus, *Leptæna*, was erected in 1827 (Kongl. Vet. Acad. Handl.) and embraced not only the type form *rhomboidalis* (under other specific names), and species of *Productus*, but also other types of *Strophomena* and *Leptæna*, as those genera are now usually understood (Meek), while Rafinesque's genus, *Strophomena*, though used by him and Defrance, in brief and unsatisfactory allusions, for several years before, was fairly published as early as 1825, when Blainville figured and published a brief description (*Man. de Malacol.*) But in this description Mr, Meek says that doubtless an American resupinate specimen, later named *planumbona* by Hall, was described under one of Rafinesque's names (*rugosa*, adopted from Dalman, applied by him to a non-resumpinate form). Hence it is evident, not only that each

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***Canadian Naturalist and Geologist*, Vol, 5, 1860 ; and *Pal. Foss.*, Vol. 1, p. 115.

author included all the forms under his own designation, but that they had not noted the distinctions that were subsequently brought out. The names must therefore be regarded as perfectly synonymous, and the earlier published, under the recognized law of priority, should take precedence.

The remarkable differences that divide these brachiopods into resupinate and non-resupinate groups. seem to call for a generic designation for the resupinate species. Provisionally therefore we shall follow the suggestion of Mr. Meek and range these species under Pander's genus *Hemipronites*, proposed in 1838 but not defined. For the present the Permian and Carboniferous name of *Streptorhynchus*, proposed by Prof. King in 1850[*], though perhaps covering some of our species according to the discrimination of Prof. James Hall in the 4th volume of the Palaeontology of New York. (p. 64) may be restricted perhaps to the rocks of that later geological horizon, when its characters are fully exemplified.

Gen. Char. Shell semi-circular, or semi-oval, with a hinge-line about equal to the transverse diameter, a convex receiving valve when adult. and a flat or concave entering valve, narrow cardinal area, inconspicuous or small and abrupt beaks, and radiately and concentrically striated exterior; receiving valve with a minute perforation in the beak, its foramen nearly or quite closed by the divided cardinal process of the other valve which is more or less covered by a deltidium rising from one or both valves[†]; visceral disc of the receiving valve frequently rugose concentrically.

STROPHOMENA MINNESOTENSIS (N. sp.)

Synonymy and Reference.—Leptaena deltoidea, *Owen*, Geol. Rep. Wisc. Iowa and Minn. p. 629, Tab. II, b. fig. 10. Winchell, Geol. & Nat. Hist. Survey, Minn. Rep. for 1872, p. 101. *Ibid* for 1876 p. 148 and 212, *Ibid* for 1879 p. 62.

Shell semi-oblong or semi-oval, with the cardinal angle about 90 degrees, or less than 90 degrees; diameter from six to nine lines transversely, and from four and a half to eight lines perpendicularly; the receiving valve convex. sometimes more suddenly deflected after passing the visceral area; entering valve gently concave, but flexed more rapidly about the margin; the exterior of the convex valve marked by fine radiating striæ, every third, fourth or fifth one being larger than the intervening ones: interior of the convex valve, which is best known from its frequent casts, shows a large muscular impression much resembling that of *S. alternata* as figured by Meek in Vol. I. Pal. Ohio, plate VII. fig. 3c. but somewhat bilobate in front, and larger in proportion to the size of the valve; scars of the abductor muscles closely approximate, small and in many casts of this valve undistinguishable; behind they are separated (on the casts) by a short merial ridge, which between them becomes at first a narrow mesial furrow and then a deep furrow, terminating at the sinus between the outer, larger, scars; the outer larger scars (cardinal muscles) are radiately striated from the beak; their margins are strongly marked (on the cast) along their posterior sides by distinct grooves formed by the dental plates, which diverge at once from the foramen at an angle of 100-120 degrees, running nearly straight to the outer margins of the muscular scar, when they curve slightly toward the front; the anterior and lateral margins of the general muscular impression are slightly marked on the casts; outside of the muscular scar is a shallow marginal impressed line which is most evident at the cardinal angles as it converges toward the beak; interior edge of the cardinal line is carinate, from the teeth to the cardinal angles; the details of the markings in the apex of the beak are seen on the valve itself to consist of two short, distinct, diverging ridges extending not much beyond the hinge-teeth, between the anterior ends of which rises a short mesial ridge of about the same size and length, with faint linuar ridges parallel with it on each side, which extend a little further forward than the mesial ridge. The mesial ridge first gives place to a flat unmarked interval, when it again rises more conspicuously, but narrower and sharper, extending nearly to the sinus separating the lobes of the outer muscular scar. The cardinal area of the convex valve slopes from the hinge-line obliquely backward, instead of being in plane with the lateral edges, thus differing from *S. alternata.* From three to five short undulations of the shell transverse to the cardinal line, are seen often between the umbo and the cardinal angles the heavier ones being near the cardinal angles. The cardinal process is bifid and prominent, but not spreading or fan-shaped, the two parts being short, smooth, dantate protuberances that stand prominently exposed about parallel with the plane of the cardinal area.

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[*] Monograph of Permian Fossils, 1850, p. 107.

[†] Prof. James Hall says (16th Reg. Rep, p. 63) that *S. rugosa (rhomboidalis)* and *S. alternata* have a deltidium on the dorsal (concave) valve. S. aspera, Jams, has also.

The interior of the entering valve is very different from that of the entering valve of *S. alternata.* The general visceral disc is nearly flat, surrounded by a suddenly flexed margin, inside of which is a shallow impressed broad line, most evident round the front:

inside the cardinal angle are a few scattered, radiately-interrupted, short ridges or elevations, but these do not prevail along the side nor in front, the surface there being smooth or finely granulated instead; in the center of the valve are five smooth, abrupt, digitately spreading ridges, the middle one of which is a little larger and longer than the others; these rise more abruptly at their anterior extremities than behind, but none of them reach the beak, or even the umbonal region, though the exterior pair of lateral ones are placed further back than the others, converging at an angle of about 70°. Socket ridges very short and widely divergent; behind them are small, doubly groved sockets.

Formation and Locality: This species occurs in the sub-crystalline dolomytic layers of the upper part of the Trenton, at Minneapolis. It exists most numerously as casts, of which hundreds are obtainable. Sometimes they nearly cover slabs when split open in quarrying, associated with *Hemipronites filitextus* (Hall), *Orthis tricenaria*, and species of *Murchesonia* and *Edmondia*. They do not vary much in size. They have been referred to in describing the rock at the falls of St. Anthony, by Dr. D. D. Owen, as *S. deltoidea*, and, following his identification, by the writer in reports of progress of the survey. Without seeing the interior of the flat valve, it is nearly impossible to distinguish this species from *S. alternata* of Conrad, except that it is much smaller than that species generally is.

Collectors. N. H. and H. V. Winchell and C. L. Herrick.

Museum Register Numbers. 3521 (=180), 681, =3522 (199), 2192 and 3523.

IV.

THE MUSEUM.

REPORT FOR 1880.

The south room of the Museum has been rendered more attractive and useful by the erection of a large, single, central case in the middle of the room, designed to contain distinctively the rocks, fossils, minerals and soils of Minnesota. Into this have been placed such portions of the survey collections as are ready to be put on exhibition, or that could be spared from the laboratories. In the lower portions of the other cases in the same room have been placed additional shelving, which nearly doubles the former capacity of those cases. Here have been arranged rock-samples from various parts of the United States, and from Europe, as well as large specimens of ores and minerals that could not be contained in the tops of the same cases. One of these has been set aside for archæological specimens.

The zoological collections in the north room have been increased by the contribution of two series of specimens by the Smithsonian Institution, constituting Set 37 of *Invertebrata*, containing 155 species, and Set 46 of *Fishes*, containing 73 species, on behalf of the United States National Museum, from collections of the United States Fish Commission, through the courtesy of Prof. S. F. Baird.

Specimens presented to the Museum will be found enumerated and acknowledged in the following catalogue:

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1880.

[GEOLOGICAL AND MINERALOGICAL.]

Serial Numbe.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.	
	When.	Whence.						
3364	May, 1879	Geol. Survey	Shakopee Limestone (fossiliferous)	Ind	Sec. 5, Stanton Good. Co	Low Mag.	N. H. Winchell	
3365	"	"	St. Lawrence Limestone	"	Frontenac, Goodhue Co	"	"	
3366	"	"	St. Lawrence Limestone	4	Red Wing, Goodhue Co	"	"	Berglund's quarry
3367	"	"	Fossiliferous chert	2	" "	St. Lawr.	"	"
3368	"	"	Dendrites	1	" "	"	"	"
3369	"	"	Drusy geodes and nodules	....	Mazeppa, Wab. Co.		"	
3370	"	"	Green Sandrock	4	Central Point	St. Croix	"	
3371	"	"	Greenish dolomitic Sandrock 1x1 ft	Ind	"	"	"	
3372	"	"	White Sandrock	....	"	"	"	
3373	"	"	Tufa (calcareous)	6	"		"	
3374	"	"	Shale (containing trilobite remains)	Ind	Barn Bluff, Red Wing	St. Croix	"	
3375	"	"	Green Sandrock	....	Hay Creek, Goodhue Co	"	"	
3376	"	"	Stalactitic calcareous coatings	3	Barn Bluff, Red Wing	St. Lawr.	"	
3377	"	"	Organic forms (orthocerata ?)	2	" "	"	"	
3378	"	"	Receptaculites. Sp. ?	1	Sec. 12 Holden Good. Co	Hud. R.	"	
3379	"	"	Fossiliferous slabs	2	Kenyon, Good. Co.	"	"	
3380	"	"	Trenton Limestone	4	Stanton, Good. Co.	Low Trent.	"	
3381	"	"	(Upper) Trenton Limestone	Ind	Kenyon, Good. Co.	Up. Trent.	"	
3382	"	"	Red Wing stone-ware clay	2	Goodhue Co.		"	
3383	"	"	"Slip Clay" (Albany, N. Y.)	1	Albany, N. Y.		"	(used at Red Wing)
3384	"	"	Stone Ware	....	Red Wing		"	
3385	"	"	Conglomerate (ferruginous)	3	Cherry Grove, Good. Co	Dakota (?)	"	
3386	"	"	St. Peter Sandstone	Ind	White Rock, Good. Co.	St. Peter	"	
3387	"	"	Combustible Shale	1	Zumbrota, Good. Co.	Trenton	"	
3388	"	"	Combustible Shale	7	Sec. 25 Stanton Good. Co	"	"	
3389	"	"	Lingula Coburgensis, Bill	1	Kenyon, Good. Co.	Up. Trent.	"	
3390	"	"	(Upper) Trenton Limestone	3	Cherry Grove, Good. Co	"	"	
3392	"	"	Trenton Limestone	4	Cannon Falls, Good. Co	Low Trent.	"	
3393	"	"	Upper Trenton Limestone	2	Sec. 8. Wanamingo, Good. Co.	Up. Trent.	"	

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
3467	1879	Geol. Survey	Calcareous Tufa	Ind	N. E. ¼, Sec 26, Fanoburg, Chip. Co	Drift	"
3468	"	"	" " (sparingly fossiliferous)	"	2½ mi. N. W. of Ortonville [Sec. 8	"	"
3469	"	"	Crag (fossiliferous) compare 3462, 3311 and 3385	12	Hawk Creek, S. E. ¼.	Drift?	"
3470	"	"	Boulder of fossiliferous Sandrock	2	3 mi. N. W. of Monticello, Wright Co	Drift	"
3471	"	"	" " Limestone	1	Sec. 34 Willmar, Kan. Co	"	"
3472	"	"	" " "	1	Dayton, Hennepin Co	"	"
3473	"	"	Pyritiferous clay, iridescent shells and selenite	....	2 mi. S. W. of Campbell, Wilk. Co	"	"
3474	"	"	Silicified wood	2	Near Campbell Wilk Co	"	" [Champion
3475	"	"	Fossiliferous pebble	1	Near Campbell Wilk Co	"	" Presented by H.
3476	"	"	From a granite boulder, 20 ft. long	1	⅓ mile S. W. from Castle Rock	"	"
3477	"	"	From a heavy doleritic boulder	1	3 mi. N. W. of Montevideo	"	W. Upham, (resembles the Duluth rock. N. H. W.)
3478	"	"	From a boulder of granite 12 inches in diameter.	3	N. W. part of Sec. 13, Hoff. Pope Co	"	" [feet all angular
3479	"	"	From a boulder of hornblende schist	2	Oscar, Otter Tail Co	"	" some fragments 3½
3180	"	"	Kidney Iron Pebble (oxidized in layers)	1	Green Lake P. O	"	" (from the Cretaceous)
3481	"	"	Glaciated Pebble	1	3 mi. N. W. of Ft Ridgely	"	"
3482	"	"	Glaciated Limestone Pebble	1	Muskoda	"	"
3494	"	"	*Strophemena aspera* (James)	3	Oxford Mills near Cannon Falls	Hud. R	N. H. Winchell
3499	1877	"	*Lingula Elderi. whit*	1	Wanamingo, Good. Co	Trenton	N. H. Winchell
3500	1879	"	*Lingula elongata* (Hall)	1	Minneapolis	"	Presented by W. D. Hurlburt
3501	Sept. 1875	"	*Lingula Elderi. whit*	2	Olmsted Co	"	same as No 291
3502	Aug. 1875	"	*Lingula Elderi. whit*	1	Fountain, Fill. Co	"	Taylor's quarry, N. H. W
3503	May 1879	"	*Lingula Elderi. whit*	1	Minneapolis	"	(same as 645)
3504	"	"	*Lingula Perryi* (Bill)	1	Minneapolis	"	H. V. Winchell [shale)
3507	Aug. 1879	"	*Crania Trentonensis* (H)	1	St. Paul	Hud. R	N. H. Winchell from 2578 (green
3508	"	"	*Crania granulosa* (Winch)	1	Minneapolis	Trenton	C. L. Herrick, from 691

3509	Mar. 1879	Geol. Survey	*Orthis tricenaria* (Con.)	Ind	Minneapolis	Trenton	Horace V. Winchell
3510	Aug. 1877	"	*Orthis plicatella* (H.)	3	St. Paul	Hud. R.	N. H. Winchell
3511	Apr. 1879	"	*Orthis testudinaria* (Dal)	1	Oxford Mills, Good. Co.	"	"
3512	"	"	*Orthis testudinaria* (Dal.)	Ind	Kenyon, Good. Co	"	"
3513	Aug. 1877	"	*Orthis perveta* (Con.) (?)	2	Minneapolis	"	C. L. Herrick (larger than type)
3514	"	"	*Orthis media* (Winch.)	12	Minneapolis	"	"
3515	Apr. 1879	"	*Orthis circularis* (Winch.)	2	Oxford Mills, Good. Co.	"	N. H, Winchell
3518	Oct. 1875	"	*Orthis subquadrata* (H.) (?)	15	Spring Valley	Galena	"
3519	July 1880	"	*Orthis Minneapolis* (Winch.)	2	Minneapolis	Hud. Riv.	C. L. Herrick
3520	Aug. 1877	"	*Orthis Sweeneyi* (Winch.)	2	St. Paul	Hud. Riv.	N. H. Winchell
3521	1872	"	*Strophomena Minnesotensis* (Winch.)	1	Minneapolis	Trenton	" (same as 180)
3522		"	*Strophomena Minnesotensis* (Winch.)	Ind	Minnehaha	"	" (same as No 199)
3523	Aug, 1880	"	*Strophomena Minnesotensis* (Winch.)	1	Minneapolis	"	C. L. Herrick (the entering
3524	May. 1879	"	*Strophemena aspera* (James)	3	Sec. 12 Holden Good. Co	Hud. R.	N. H. Winchell [valve.)
3525	Apr., 1879	"	*Strophemena aspera* (James)	13	Kenyon, Good. Co	"	" [Honolulu
3526	Apr., 1880	H. P. Vancleve	Volcanic Rock (basic)	2	Sandwich Islands	Igneous	From quarry S. of Punchbowl at
3527	"	"	Volcanic Tufa	1	"	"	From quarry S. of " "
3528	"	"	Volcanic Rock (gray)	1	"	"	From rock W. of " "
3529	"	"	Basaltic Column	1	"	"	Pali, head of Nuuani V'y,Oahee
3530	"	"	Rock Samples	4	"	"	" " "
3531	"	"	Volcanic Tufa	5	"	"	15,000 feet above the ocean
3532	"	"	Volcanic Scoria	1	"	"	[problematicus
3533	1873	Geol. Survey	Niobrara, calcareous shale	1	Near Sioux City, Iowa	Niobrara	N. H. W. shows Inoceramus
3534	May, 1880	S. S. Strong	*Pecopteris villosa* (Brugt.)	2	Mazon Creek, Grundy Co. Ill.	Coal Meas.	
3535	"	"	*Pecopteris hirsuta* (Lesgr.)	2	Mazon Creek, Grundy Co. Ill.	"	
3536	"	"	*Pecopteris unita* (Brugt.)	2	Mazon Creek, Grundy Co. Ill.	"	
3537	Nov. 1879	M. Pettengill	Petrified Wood	1	Wyoming Territory near Yel'stone Park		Through Regent Chute
3538	1875	Asb. Stone Co.	Asbestine Stone	1	Minneapolis		Manufactured at Minneapolis
3539	1880		*Ostrea falcata*	14		Cretaceous	No records
3540	1880		*Ostrea larva*	1		"	"
3541	1876	Centennial Exp.	Coal	2	Orange Free State		N. H. Winchell
3542	1873		Barite	1	Massachusetts		Records doubtful
3543	1879	Geol. Survey	Building Stone 1 ft. square	1	Red Wing	St. Law.	N. H. W. (Berglund's quarry)
3544	1875	"	" "	1	Mantorville	Galena	" (Wilson's quarry)
3545	1879	"	" "	1	Frontenac	St. Law.	" (Frontenac Stone Co.)
3546	1875	"	" "	1	Austin		"
3547	1879	"	" "	1	Fond du Lac	Potsdam	"
3548	Apr. 1876	"	Barite and Galenite	2	Potosi Mines, Mo.		Hon. Wm. R. Marshall
3549	Apr. 1880	A. R. McNair	Stromatopora (sp. ?)	1	Saratoga, New York	Trenton	Capt. A. R. McNair
3550	1873	Geol. Suavey	St. Cloud red granite	1	St. Cloud		N. H. Winchell
3551	May, 1880	"	Drillings from artesian well at 310 feet		Mankato		Warren Upham
3552	"	"	" " 330 feet		"		"
3553	"	"	" " 380 feet		"		"
3554	"	"	" " 390 feet		"		"

Specimens Registered in the General Museum in 1880—Continued.

Serial number.	OBTAINED.		NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
	When.	Whence.					
3555	May, 1880	Geol. Survey	Drillings from artesian well at 450 feet		Mankato		Warren Upham
3556	"	"	" " 495 feet		"		"
3557	"	"	" " 560 feet		"		"
3558	"	"	" " 600 feet		"		"
3559	"	"	" " 640 feet		"		"
3560	"	"	" " 645 feet		"		"
3561	"	"	" " 660 feet		"		"
3562	"	"	" " 1060 feet		"		"
3563	"	"	" " 1100 feet		"		"
3564	"	"	" " 1110 feet		"		"
3565	"	"	" " 1130 feet		"		"
3566	"	"	" " 1150 feet		"		"
3567	"	"	" " 1270 feet		"		"
3568	"	"	" " 1280 feet		"		"
3569	"	"	" " 1320 feet		"		"
3570	"	"	" " 1327 feet		"		"
3571	"	"	" " 1332 feet		"		"
3572	"	"	" " 1342 feet		"		"
3573	"	"	" " 1450 feet		"		"
3574	"	"	" " 1720 feet		"		"
3575	"	"	" " 1827 feet		"		"
3576	"	"	" " 1860 feet		"		"
3577	"	"	" " 2000 feet		"		"
3578	"	"	" " 2150 feet		"		"
3579	"	"	" " 2204 feet		"		"
3580	"	Mus. of Technol'gy	Halite	1	Wieliezka, Galicia		Liquid cavities with gas bubbles
3581	May, 1879	Geol. Survey	Trap-rock showing corrugated cooled surface	1	Temperance River	Cuprifero's	N. H. Winchell (No. 170 of sur.)
3582	Sep., 1878	"	Basalt columns	3	Grand Marias	"	N. H. Winchell (No. 536 of sur.)
3583	May, 1880	"	Building stone, 1 foot square	1	Minneapolis	Trenton	N. H. Winchell
3584	Dec. 1879	"	Fool's gold. (Rusty mica and sand	Ind	Western Minnesota	Drift	Presented
3585	May, 1880	Prof. P. H. Mell, Jr	*Natica striata*	1	Claibourne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3586	"	"	*Natica magna-umbilicata*	1	"	"	"
3587	"	"	*Natica mamma*,	1	"	"	"

3588	Apr., 1880	Prof. P. H. Mell, Jr	*Oliva constricta*	1	Claiborne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3589	“	“	*Oliva dubia*	1	“	“	“
3590	“	“	*Oliva gracilis*	1	“	“	“
3591	“	“	*Rostellaria cuvieri*	1	“	“	“
3592	“	“	*Rostellaria Lamarkii*	1	“	“	“
3593	“	“	*Voluta Parkinsonii*	1	“	“	“
3594	“	“	*Marginella semen*	1	“	“	“
3595	“	“	*Marginella crassitabea*	1	“	“	“
3596	“	“	*Egeria subtrigonia*	1	“	“	“
3597	“	“	*Egeria rotunda*	1	“	“	“
3598	“	“	*Egeria veneriformis*	1	“	“	“
3599	“	“	*Pyrula concellata*	1	“	“	“
3600	“	“	*Corbula Murchisonii*	1	“	“	“
3601	“	“	*Corbula Alabamiensis*	1	“	“	“
3602	“	“	*Venericardia parva*	1	“	“	“
3603	“	“	“ *transversa*	1	“	“	“
3604	“	“	“ *rotunda*	1	“	“	“
3605	“	“	“ *planicosta* (Con.)	1	“	“	“
3606	“	“	*Pectunculus minor*	1	“	“	“
3607	“	“	“ *deltoidea*	1	“	“	“
3608	“	“	“ *ellipsis*	1	“	“	“
3609	“	“	“ *obliqua*	1	“	“	“
3610	“	“	“ *broderipii*	1	“	“	“
3611	“	“	*Nassa cancellata*	1	“	“	“
3612	“	“	*Buccinum Sowerbii*	1	“	“	“
3613	“	“	*Turbinolia pharetra*	1	“	“	“
3614	“	“	“ *discoidea*	1	“	“	“
3615	“	“	“ *Maclurii*	1	“	“	“
3616	“	“	“ *Stokesii*	1	“	“	“
3617	“	“	*Dentalium alternatum*	1	“	“	“
3618	“	“	“ *turitum*	1	“	“	“
3619	“	“	*Astarte minutissima*	1	“	“	“
3620	“	“	“ *Nicklinsii*	1	“	“	“
3621	“	“	*Teredo simplex*	1	“	“	“
3622	“	“	*Turritella lineata*	1	“	“	“
3623	“	“	“ *carinata*	1	“	“	“
3624	“	“	“ *umbricata* (Lam.)	1	“	“	“
3625	“	“	*Mitra fusoides*	1	“	“	“
3626	“	“	“ *lineata*	1	“	“	“
3627	“	“	*Ostrea divaricatus*	1	“	“	“
3628	“	“	*Turbo natacoides*	1	“	“	“
3629	“	“	*Cerithium striatum*	1	“	“	“
3630	“	“	*Lucina impressa*	1	“	“	“
3631	“	“	“ *lunata*	1	“	“	“
3632	“	“	“ *papyracea*	1	“	“	“
3633	“	“	“ *compressa*	1	“	“	“
3634	“	“	Bone of a fish (?)	1	“	“	“
3635	“	“	*Bulla St. Hillairia*	1	“	“	“

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3636	May, 1880	Prof. P. H. Mell, Jr	*Fusus bicarinatus*	1	Claibourne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3637	"	"	Shark's tooth	1	"	"	"
3638	"	"	*Plicatula Mantelli*	1	"	"	"
3639	"	"	*Cytheria Hydii*	1	"	"	"
3640	"	"	" *subcrassa*	1	"	"	"
3641	"	"	" *cornis*	1	"	"	"
3642	"	"	*Orbitolites interstitia*	1	"	"	"
3643	"	"	*Limulites Douglassi*	1	"	"	"
3644	"	"	" *Bouci*	1	"	"	"
3645	"	"	*Crepidula cornu-arietis*	1	"	"	"
3646	"	"	*Crassatella protexta* (Con.)	1	"	"	"
3647	"	"	" *alta* (Con.)	1	"	"	"
3648	"	"	*Siliquaria Clatbornensis*	1	"	"	"
3649	"	"	*Solarium granulatum*	1	"	"	"
3650	"	"	*Egeria inflata*	1	"	"	"
3651	"	"	*Voluta cooperi*	1	"	"	"
3652	"	"	*Mitra Humboldtii*	1	"	"	"
3653	"	"	*Oliva Greenougii*	1	"	"	"
3654	"	"	*Mitra Flemingii*	1	"	"	"
3655	"	"	*Egeria inflata*	1	"	"	"
3656	"	"	*Marginella ovata*	1	"	"	"
3657	"	"	*Nucula media*	1	"	"	"
3658	"	"	" *Sedgewickii*	1	"	"	"
3659	July, 1880	Geol. Survey	Fossil marble	3	Isle Lamatte, G'd Isle Co., Vt.		S. F. Heath
3660	"	"	Calico marble	4	Swanton, Franklin Co, Vt.		"
3661	"	"	French gray marble	5	Isle Lamatte, G'd Isle Co., Vt.		"
3662	"	"	Hard marble—used for tiles	3	Sutherland Falls, Rutland Co., Vt.		"
3663	"	"	Dove marble	3	Swanton, Franklin Co. Vt.		"

3664	July, 1880	Geol. Survey	Green slate	1	Fairfield, Rutland Co., Vt.		S. F. Heath	
3665	"	"	Brandon marble	1	Wheaton Quarry, Brandon, Vt.		"	
3666	"	"	Sutherland Falls marble	1	Sutherland Falls, Vt.		"	Average grade
3667	"	"	Rutland statuary marble	2	Rutland, Rutland Co., Vt		"	
3668	"	"	Governeur marble	1	Governeur, New York		"	
3669	"	"	Middleburry marble	1	Middlebury, Vt.		"	
3670	"	"	Red marble	3	Swanton, Franklin Co, Vt.		"	
3671	"	"	Black marble	4	Isle Lamatte, G'd Isle Co., Vt.		"	
3672	"	"	Sutherland Falls marble, grade No. 1	1	Sutherland Falls, Rutland Co., Vt.		"	
3673	"	"	" " grade No. 2	1	Sutherland Falls, Rutland Co., Vt.		"	
3674	"	"	" " grade No. 3	1	Sutherland Falls, Rutland Co., Vt.		"	
3675	"	"	" " best grade No. 3	1	Sutherland Falls, Rutland Co., Vt.		"	
3676	"	"	Rutland marble (averages)	1	Rutland, Rutland Co., Vt		"	
3667	"	"	Columbian marble	2	Rutland, Rutland Co., Vt		"	
3678	"	"	Sutherland Falls marble	1	Sutherland Falls, Rutland Co., Vt.		"	
3679	"	"	Marble	1	Pittsford, Rutland Co., Vt.		"	
3680	"	"	Columbian marble	1	Rutland, Rutland Co., Vt.		"	
3681	"	"	Itallan marble	1			"	
3682	"	"	Purple slate	2	Hydeville, Rutland Co. Vt.		"	
3683	"	"	Purple slate	2	Fairfield, Rutland Co., Vt.		"	(Vt. Union Co.)
3684	"	"	Red slate	2	Fairfield. Rutland Co., Vt.		"	"
3685	"	"	Green slate	1	Fairfield, Rutland Co., Vt.		"	"
3686	"	"	Green slate	2	Hydeville, Rutland Co. Vt.		"	
3687	"	"	Soapstone	2	Cambridgeport, Westminster, Windom Co., Vt.		"	(Smith quarry)
3688	"	"	Marble	1	Dorsant, Rutland Co, Vt.		"	
3689	"	"	Laponto marble	1	Hudson, N. Y		"	
3690	"	"	Westerly marble	1	Westerly, R. I		"	
3691	"	"		1	Chester, Vt.		"	
3692	"	"		1	Fitz William, N. H		"	
3693	"	"	Granite	2	Slayton, N. Y		"	

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	Where.	When.					
3694	July, 1880	Geol. Survey		1	Fitz William, N. H		S. F. Heath
3695	"	"	Granite	2	Quincy, N. H		"
3696	"	"	Iron ore (magnetite)	2	Port Henry, N. Y		"
3697	"	"			Sutherland Falls, Vt		" from marble quarry
3698	"	"	Maria marble	3	Grand Haven, N. Y		"
3699	"	"	Building stone	4	Burlington, Vt		"
3700	"	"	Black marble	2	Glen Falls, N. Y		"
3701	"	"	Brandon marble	2	Brandon, Rutland Co., Vt		" (Goodell quarry)
3702	"	"	Marble	3	" " "		" Trojan Marble Co.
3703	"	"	Brandon statuary marble	2	" " "		" Goodell quarry
3704	"	"	Laponto	1	Lake Lamotte, Grand Isle Co., Vt		"
3705	"	"		1	Brandon, Rutland Co., Vt		" (Goodell quarry)
3706	"	"	Lignite	1	" " "		"
3707	"	"	Lignite ore	1	" " "		"
3708	"	"	Kaolin (unwashed)		" " "		"
3709	"	"	Kaolin (washed)		" " "		"
3710	"	"	Gypsum (used as land dressing)		Nova Scotia		"
3711	"	"	Graphite	1	Caledonia Co., Vt		"
3712	"	"	Scythe stone	2	Northfield, Washington Co., Vt		"
3713	"	"	Granite	2	McViele, Caledonia Co. Vt		"
3714	"	"	Granite	1	Berlin, Wash. Co., Vt		"
3715	"	"	Granite	1	Cabot, Caledonia Co., Vt.		" [State house is b'lt
3716	"	"	Barre Granite	3	Barre, Wash. Co., Vt		" Stone from which Vt
3717	"	"	Woodbury granite	2	Woodbury, Washington Co., Vt		"
3718	"	"	Granite	2	Calais, Wash. Co., Vt		" From a boulder
3719	"	"	Slate	2	Northfield, Wash. Co., Vt		"
3720	"	"		2	Calais, Wash. Co., Vt		"
3721	"	"	Verde antique	4	Roxbury, Wash. Co., Vt.		"
3722	"	"		8	Plainfield, Wash. Co., Vt.		"

3723	July, 1880	Geol. Survey......	....	2	Elmore, Lamoile Co., Vt	....	S. F. Heath......................
3724	"	"	Building stone..	1	Isle Lamotte. Vt.........	....	" ....
3725	"	"	....	1	Woodbury, Wash. Co., Vt	....	" From top of Wood-
3726	"	"	....	1	" " "	....	" ....[bury Mt.
3727	"	"	....	8	" " "	....	" ....
3728	"	"	Castoroides Ohioensis (Foster)......................	1	Minneapolis.............	Drift.......	N. H. Winchell. Lower left ramus and incisor...........
3729	Aug., 1888	"	Granular quartzyte pebble.........................	1	Ten-mile Lake, Big Stone Co............	Drift.......	From E. R. Harkness (banded with iron)................
3730	"	"	Pressed brick (red)................................	1	St. Louis, Mo............	....	N. H. W. (Tabernacle Church)
3731	"	"	Resembles *Strophomena incrassata* (H.)..........	1	St. Paul.................	Hud. Riv..	N. H, W. Interior of dorsal valve......................
3732	Oct., 1880	"	*Strophomena alternata* (Con.)....................	3	Spring Valley...........	Galena	N. H. W. (--275)................
3733	Mch, 1880	"	*Hemipronites filitextus* (H.)......................	5	Minneapolis.............	Trenton....	H. V. Winchell (casts of interior of entering valve.......
3734	"	"	*Hemipronites filitextus*	3	Minneapolis.............	Trenton....	H. V. W. (perfect casts of interior of both valves).......
3735	Apr., 1880	"	*Hemipronites subumbonus* (H.)..................	1	Kenyon, Goodhue Co...	Hud. Riv..	N. H. Winchell (ventral valve)

ZOOLOGICAL ACCESSIONS TO THE MUSEUM.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
1		Cervus canadensis, Erx	M.	Black Hills, Da.	M'td.	N. H. Winchell.	Aug., 1874	Aug., 1874	Geol. & N. H. Sur.	1	Custer Exp.
2		Ursus horribilis, Ord	F.	"	"	"	"	"	"	1	"
3		Antilocapra americana, Ord	M.	"	"	"	"	"	"	1	"
4		Antilocapra americana, Ord	M.	"	"	"	"	"	"	1	"
5		Antilocapra americana, Ord	F.	"	"	"	"	"	"	1	"
6		Cervus leucurus, Doug	M.	"	"	"	"	"	"	1	"
7		Cervus leucurus, Doug	F.	"	"	"	"	"	"	1	"
8		Cervus macrotis, Say	M.	"	"	"	"	"	"	1	" Young
9		Taxidea americana, Bd		"	"	"	"	"	"	1	"
10		Alce americanus, Jordine	M.	Otter Tail Co., Mn.	"	Peter Young	Dec., 1874		"	1	
11		Lepus calotis, Wagler (?)		Currie, Minn.	"	C. L. Herrick	Oct., 1877	Oct., 1877	"	1	
12		Arctomys monax, (L.) Gm			"					1	
13		Procyon lotor, (L.) Storr.		Lake Minnetonka.	"	C. L. Herrick	July, 1875	July, 1876	Geol. & N. N. Sur.	1	
14		Erethizon dorsatus, (L.) F. Cuv		Lake Superior	"	N. H. Winchell.	1879	1879	"	1	
15		Rangifer caribou, Aud. & Bach		Lake Superior	"		1876		N. Butler	1	Presented
16		Lynx rufus, (Guld.) Raf		New Ulm	Skin	B. Juni	1879	1879	B. Juni	1	
17		Putorius vison, Gapper		Lake Superior	M'td	N. H. Winchell.	1878	1878	Geol. & N. H. Sur.	1	Purchased
18		Mustela americana, Turton		"	"	"	1878	1878	"	2	"
19		Lutra canadensis, Sabine		"	"	"	1878	1878	"	1	"
20		Mustela pennantii, Erx		"	"	"	1878	1878	"	1	"
21		Blarina brevicaudata, (Say.) Bd. ?		Minneapolis	"	H. V. Winchell.	1878	1878	H. V. Winchell	1	
22				Black Hills, Da.	"			1877	Mr. Howling	1	Chinchilla
23		Geomys bursarius, (Shaw) Rich		Minneapolis	"	H. V. Winchell.	1878	1878	H. V. Winchell	1	
24		Spermophilus franklini, (Sab.) Rich		"	"	"	1878	1878	"	1	
25		Castor fiber, L.	M.	Lake Superior	"	N. H. Winchell.	1879	1879	Geol. & N. H. Sur.	1	Purchased
26		Castor fiber, L.	F.	"	"	"	1879	1879	"	1	"
27		Sciurus hudsonicus, Pallas	M.	Devils Track L.	kin	T. S. Roberts	Aug. 16, '79	Aug. 16, '79	"		
28		Tamias quadrivittatus, (Say.) Wag.		Devil's Track L.	"	"	Aug. 21, '79	Aug. 21, '79	"	1	Variable
29		Tamias quadrivittatus, (Say.) Wag.		Duluth	"	"	Sep. 1, 1879	Sep. 1, 1879	"	1	"
30		Tamias quadrivittatus, (Say.) Wag.		Grand Marais	"	"	Aug. 21, '79	Aug. 21, '79	"	1	"
31		Tamias quadrivittatus, (Say.) Wag.		"	"	"	Aug. 10, '79	Aug. 10, '79	"	1	"
32		Tamias quadrivittatus, (Say.) Wag.		"	"	"	Aug. 10, '79	Aug. 10, '79	"	1	"
33		Tamias quadrivittatus, (Say.) Wag.		Duluth	"	"	Sep. 1, 1879	Sep. 1, 1879	"	1	"

34	....	Tamias striatus, (L.) Bd			Skin	T. S. Roberts				1	
35	....	Hesperomys cucopus (?)	M.	Poplar R. and S.	"	T. S. Roberts	Aug. 6, 1879	Aug. 6, 1879	Geol. & N. H. Sur.	1	
36	....	Sciurus hudsonicus, Pal		Minneapolis	M'td	C. L. Herrick	July, 1876	July, 1876	"	1	
37	....	Sciurus hudsonicus, Pal		"	"	"	"	"	"	1	
38	....	Tamias striatus, (L.) Pal		"	"	"	"	"	"	1	
39	....	Sciurus carolinensis, Auct		"	"	"	"	"	"	1	
40	....	Spermophilus tridecem—lineatus, Mitch		"	"	"	"	"	"	1	
41	....	Sciurus carolinensis, Auct		"	Skin	"	1876	1877	C. L. Herrick	1	Presented
42	....	Tamias striatus, (L.) Bd		"	"	"	1876	1877	"	1	"
43	....	Geomys bursarius, (Shaw.) Rich		"	"	"	1877	1877	"	1	"
44	....	Hesperomys michiganensis, And. & Bach.) Wag. ?		"	M'td	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	
45	....	Canis familiaris grajus hibernicus, Gm	M.	"	"	E. S. Williams	1879	1879	Mr. Williams	....	Greyhound of [Gen. Custer
46	....	Vespertilio subulatus, Say		Beaver Bay	Alc'hol	N. H. Winchell	1879	1879	Geol. & N. H. Sur.	....	
47	....	Mus (?)			"						
48	....	Vespertilio subulatus, Say		Grand Marais	"	C. W. Hall	1879	1879	Geol. & N. H. Sur.	1	
49	....	Vespertilio subulatus, Say		"	"	"	1879	1879	"	1	
50	....	Turdus migratorius, L		Minneapolis	Skin	C. L. Herrick	May, 1875	1876	C. L. Herrick	1	Presented
51	....	Harporhynchus rufus, Cab		"	"	"	Aug., 1876	Aug. 20, '76	Geol. & N. H. Sur.	1	
52	....	Hylocichla swainsoni		"	"	"	May 14, '75	1876	C. L. Herrick	1	Presented
53	....	Galeoscoptes carolinenisis, (L.) Cab.	M.	"	"	"	May 14, '75	1876	"	1	"
54	....	Sialia sialis, (L.)	M.	"	"	"	1877	1877	Geol. & N. H. Sur.	1	
55	....	Regulus satrapa, Licht	F.	S. W. Minnesota	"	"	Oct., 1877	Oct., 1877	"	1	
56	....	Parus atricapillus, L		Minneapolis	"	"			"	1	
57	....	Sitta carolineusis, Gm	M.	"	"	"	Aug. 12, '76	Aug. 12, '76	"	1	
58	....	Sitta carolinensis, Gm		"	"	"	Feb., 1877	Feb., 1877	"	1	
59	....	Sitta carolinensis, Gm		"	"	"	July 24, '76	July 24, '76	"	1	
60	....	Sitta canadensis, Bd	*M.	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
61	....	Troglodytes aedon, var.?, Coues	M.	"	"	"	May 22, '75	1876	C. L. Herrick	1	Presented
62	....	Cestothorus stellaris, Cab		"	"	"	June 21, '71	June 21, '77	Geol. & N. H. Sur.	1	
63	....	Erenophila alpestris, Boie		"	"	"	M'ch 31, '75	1876	C. L. Herrick	1	Presented
64	....	Eremophila alpestris, Boie	M.	"	"	"	Feb. 26, '78	Feb. 26, '78	"	1	"
65	....	Mniotilla varia, Vieill	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	Geol. & N. H. Sur.	1	
66	....	Mniotilla varia, Vieill		"	"	"	"	"	"	1	
67	....	Mniotilla varia, Vieill		"	"	"	"	"	"	1	
68	....	Seiurus aurocapillus, Sw	M.	"	"	"	Aug. 20, '76	Aug. 20, '76	"	1	
69	....	Seiurus auricapillus, Sw	M.	"	"	"	May 15, '75	1876	C. L. Herrick	1	Presented
70	....	Seiurus novemboracensis, Sw		"	"	"	Aug. 14, '76	Aug. 14, '76	Geol. & N. H. Sur.	1	
71	....	Dendrœca aestiva, Bd	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
72	....	Dendrœca aestiva, Bd		"	"	"	May 7, 1875	1876	C. L. Herrick	1	Presented
73	....	Dendrœca aestiva, Bd	M.	"	"	"	Aug. 14 '76	Aug. 14, '76	Geol. Survey	1	
74	....	Dendrœca coronata, Gray		"	"	"	Apr., 1878	Apr., 1878	C. L. Herrick	1	Presented
75	....	Dendrœca coronata, Gray		"	"	"	May 15, '75	1876	"	1	"
76	....	Dendrœca coronata, Gray		"	"	"	1876	1876	Geol. Survey	1	
77	....	Dendrœca pennsylvanica, (L.) Bd	M.	"	"	"	July 4, 1877	July 4, 1877	Geol. & N. H. Sur.	1	
78	....	Dendrœca virens, (Gm.) Bd	F.	"	"	"	May 24, '77	May 24, '77	C. L. Herrick	1	Presented

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number	NAME.	Sex	Locality.	Nature of Specimens.	Collected by	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
79	....	Dendrœca palmarum, (Gm.) Bd....	....	Minneapolis......	Skin...	C. L. Herrick....	May 4, 1878	May 4, 1878	C. L. Herrick......	1	Presented.....
80	....	Setophaga ruticilla, (L.) Sw.........	M.	"	" ...	"	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	....
81	....	Setophaga ruticilla, (L.) Sw.........	....	"	" ...	"	Aug. 15, '76	Aug. 15, '76	"	1	....
82	....	Setophaga ruticilla, (L.) Sw.........	....	"	" ...	"	Aug. 20, '76	Aug. 20, '76	"	1	....
83	....	Pyranga rubra, (L.) Vieill............	M.	"	" ...	"	Aug. 19, '76	Aug. 19, '76	"	1	....
84	....	Tachycineta bicolor, (Vieill) Cones.	M.	L. Minnetonka....	" ...	"	Aug. 4, 1876	Aug. 4, 1876	"	1	....
85	....	Progne subis, Bd......................	M.	Minneapolis......	" ...	"	June 1, 1875	1876	C. L. Herrick......	1	Presented ....
86	....	Ampelis cedrorum, (Vieill) Bd......	M.	"	" ...	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	....
87	....	Ampelis cedrorum, (Vieill) Bd......	F.	"	" ...	"	Apr., 1877	1877	C. L. Herrick......	1	Presented.....
88	....	Ampelis cedrorum, (V.) Bd..........	....	"	" ...	"	Apr. 18, '77	1877	"	1	" .....
89	....	Ampelis cedrorum, (V.) Bd..........	M.	"	" ...	"	1875	1876	"	1	" .....
90	....	Vireo olivacea, L......................	M.	"	" ...	"	July 19, '76	July 19, '76	Geol. & N. H. Sur.	1	....
91	....	Vireo olivacea, L......................	M.	"	" ...	"	June 20, '78	June 20, '78	"	1	....
92	....	Vireo gilous, Vieill....................	M.	"	" ...	"	Aug. 11, '76	Aug. 11, '76	"	1	....
93	....	Vireo flavifrons, Vieill................	....	"	" ...	"	Aug. 16, '76	Aug. 16, '76	"	1	....
94	....	Vireo philadelphicus, Cas............	....	"	" ...	"	"	"	"	1	....
95	....	Vireo philadelphicus, Cas............	....	"	" ...	"	Aug. 20, '76	Aug. 20, '76	"	1	....
96	....	Collurio borealis, Bd.................	M.	S. W. Minnesota..	" ...	"	Oct., 1877	Oct., 1877	"	1	Young.........
97	....	Collurio borealis, Bd.................	M.	" ..	" ...	"	"	"	"	1	....
98	....	Collurio ludovicianus, L..............	....	Minneapolis......	" ...	"	1875	1875	C. L. Herrick......	1	Presented.....
99	....	Collurio ludovicianus, L..............	M.	"	" ...	"	Aug., 1876	Aug., 1876	Geol. & N. H. Sur.	1	....
100	....	Collurio ludovicianus, L..............	....	"	" ...	"	July 20, '76	July 20, '76	"	1	....
101	....	Pinecola enucleator, (L.) Vieill.....	M.	"	" ...	"	M'ch 6, '75	1876	C. L. Herrick......	1	Presented.....
102	....	Chrysomitris tristis, (L.) Bon........	M.	Champlin........	" ...	"	June 18, '75	1876	"	1	" .....
103	....	Chrysomitris tristis, (L.) Bon........	M.	....	" ...	"	Nov. 26, '75	1876	"	1	" .....
104	....	Plectrophanes nivalis, Meyer.......	M.	Minneapolis......	" ...	"	Nov. 30, '76	Nov. 1876	"	1	" .....
105	....	Plectrophanes nivalis, Meyer.......	F.	"	" ...	"	"	"	"	1	" .....
106	....	Plectrophanes lapponicus,(L.) Selby	....	S. W. Min., prairie	" ...	"	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	....
107	....	Plectrophanes lapponicus.(L.) Selby	....	Minneapolis......	" ...	"	1879.	1879	C. L. Herrick......	1	Presented.....
108	....	Aegiothus linaria, (L.) Cab..........	....	"	" ...	"	1875	1876	"	1	" .....
109	....	Poœcetes gramineus, (Gm.) Bd.....	M.	"	" ...	"	Aug., 1876	Aug., 1876	Geol. & N. H. Sur.	1	....
110	....	Poœcetes gramineus, (Gm.) Bd.....	....	"	" ...	"	Aug. 16, '76	Aug. 16, '76	"	1	....
111	....	Poœcetes gramineus, (Gm.) Bd.....	....	"	" ...	"	Apr., 1877	Apr., 1877	C. L. Herrick......	1	Presented.....

112	....	Ammodromus passerinus,(Wils.) Bd	M.	Minneapolis.......	Skin...	C. L. Herrick....	May, 1875	1876	C. L. Herrick......	1	Presented.....
113	....	Ammodromus passerinus,(Wils.) Bd	F.	"	" ...	"	July 16, '77	July 16, '77	Geol. & N. H. Sur.	1	....
114	....	Passerculus savanna, (Wils.) Bon...	....	"	" ...	"	June 21, '77	June 21, '77	"	1	....
115	....	Ammodromus lecontei, (And.) Bd..	M.	"	" ...	"	"	"	"	1	....
116	....	Ammodromus lecontei, (And.) Bd..	M.	"	" ...	"	"	"	"	1	Young.........
117	....	Chondestes grammaca, (Say.) Bon..	M.	"	" ...	"	1875	1876	C. L. Herrick......	1	Presented.....
118	....	Chondestes grammaca, (Say.) Bon..	....	"	" ...	"	1875	1876	"	1	" ....
119	....	Chondestes grammaca, (Say.) Bon..	M.	"	" ...	"	May 5, 1877	1877	"	1	" ....
120	....	Chondester grammaca, (Say.) Bon..	....	"	" ...	"	"	1877	"	1	" ....
121	....	Spizella monticola, (Gm.) Bd........	....	"	" ...	"	....	1877	"	1	" ....
122	....	Spizella monticola, (Gm.) Bd........	....	"	" ...	"	....	....	"	1	" ....
123	....	Spizella monticola, (Gm.) Bd........	....	"	" ...	"	....	....	"	1	" ....
124	....	Spizella monticola, (Gm.) Bd........	M.	"	" ...	"	Oct. 9, 1878	1878	"	1	" ....
125	....	Spizella pallida, (Sw.) Bon..........	....	"	" ...	"	May 7, 1875	1876	"	1	" ....
126	....	Spizella pallida, (Sw.) Bon..........	....	"	" ...	"	....	....	Geol. & N. H. Sur.	1	....
127	....	Spizella pallida, (Sw.) Bon..........	....	"	" ...	"	Aug., 1876	Aug., 1876	"	1	....
128	....	Spizella socialis, (Wils.) Bon........	M.	"	" ...	"	Aug. 14 ,'76	Aug. 14, '76	"	1	....
129	....	Melospiza melodea, (Wils.) Bd......	M.	"	" ...	"	1875	1876	C. L. Herrick......	1	Presented.....
130	....	Melospiza melodea, (Wils.) Bd......	....	"	" ...	"	Aug. 12, '76	Aug. 12, '76	Geol. & N. H. Sur.	1	....
131	....	Melospiza palustris, (Wils.) Bd......	....	"	" ...	" ...	Apr. 31, '77	1877	C. L. Herrick......	1	Presented.....
132	....	Melospiza palustris, (Wils.) Bd......	....	L. Minnetonka....	" ...	"	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	....
133	....	Junco hyemalis, (L.) Scl....	M.	Minneapolis.......	" ...	"	April, 1877	1877	C. L. Herrick......	1	Presented.....
134	....	Junco hyemalis, (L.) Scl.............	....	"	" ...	"	Oct. 9, 1876	Oct., 1876	"	1	" ....
135	....	Passerella iliaca, Sw................	....	"	" ...	"	1875	1878	"	1	" ....
136	....	Passerella iliaca, Sw................	....	"	" ...	"	....	....	"	1	" ....
137	....	Passerella iliaca, Sw................	....	"	" ...	"	Sept. 17, '77	1877	"	1	" ....
138	....	Euspiza americana, Bon.............	M.	"	" ...	"	1877	1877	Geol. & N. H. Sur.	1	....
139	....	Goniaphea ludoviciana, Bowd......	....	"	" ...	"	June 5, 1875	1876	C. L. Herrick......	1	Presented.....
140	....	Goniaphea ludoviciana, Bowd......	M.	"	" ...	"	"	1876	"	1	" ....
141	....	Goniaphea ludoviciana, Bowd......	F.	"	" ...	"	1876	1876	Geol. & N. H. Sur.	1	....
142	....	Cyanospiza cyanea, (L.) Bd.........	M.	"	" ...	"	....	....	"	1	....
143	....	Cyanospiza cyanea, (L.) Bd.........	M.	"	" ...	"	July, 1876	July, 1876	"	1	....
144	....	Cyanospiza cyanea, (L.) Bd.........	M.	"	" ...	"	July 8, 1878	July, 1878	C. L. Herrick......	1	Presented.....
145	....	Pipilo erythrophthalmus, (L.)Vieill.	M.	"	" ...	"	Aug. 3, 1876	Aug. 3, 1876	Geol, & N. H. Sur.	1	....
146	....	Pipilo erythrophthalmus, (L.) Vieill.	....	"	" ...	"	....	....	"	1	....
147	....	Dolichonyx oryzviorus, Sw..........	M.	"	" ...	"	July 20, '76	July 20, '76	"	1	....
148	....	Ægelæus phœniceus, (L.) V.........	F.	"	" ...	"	June, 1875	1876	C. L. Herrick......	1	Presented.....
149	....	Ægelæus phœniceus, (L.) V.........	M.	"	" ...	"	Aug. 4, 1876	Aug. 4, '76	Geol. & N. H. Sur.	1	....
150	....	Xanthocephalus icterocephalus, (Bon.) Bd.........................	....	....	" ...	"	....	....	....	1	....
151	....	Sternella magna, (L.) Sw............	M.	Minneapolis.......	" ...	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	....
152	....	Icterus baltimore, (L.) Bon..........	M.	"	" ...	"	May 22, '75	1876	C. L. Herrick......	1	Presented.....
153	....	Icterus spurius, (L.) Bon.............	M.	"	" ...	"	May 15, '75	1876	"	1	" ....
154	....	Icterus spurius, (L.) Bon,............	M.	"	" ...	"	"	1876	"	1	" Young
155	....	Icterus spurius, (L.) Bon.............	F.	"	" ...	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	....
156	....	Corvus americanus, And............	....	Green Isle.........	" ...	"	Oct., 1877	Oct., 1877	"	1	....
157	....	Cyanurus cristatus, (L.) Sw..........	....	"	" ...	"	July 20, '77	July 20, '77	"	1	....
158	....	Tyrannus carolinensis, (L.) Bd......	M.	"	" ...	"	May 14, '75	1876	C. L. Herrick......	1	Presented.....

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
159	....	Contopus virens, (L.) Cab.	M.	Minneapolis	Skin	C. L. Herrick	Aug. 11, '76	Aug. 11, '76	Geol. & N. H. Sur.	1	....
160	....	Contopus virens, (L.) Cab.	....	“	“	“	Aug. 15, '76	Aug. 15, '76	“	1	....
161	....	Contopus virens, (L.) Cab.	....	“	“	“	July, 1876	July, 1876	“	1	....
162	....	Contopus virens, (L.) Cab.	M.	“	“	“	Aug. 5, 1876	Aug. 5, 1876	“	1	....
163	....	Empidonax minimus, Bd.	M.	“	“	“	June 13, '78	June 13, '78	“	1	....
164	....	Antrostomus vociferus, (Wils.) Bon.	....	“	“	“	July, 1876	July, 1876	“	1	....
165	....	Chordeiles virginianus, Bon.	M.	“	“	“	Aug. 16, '76	Aug. 16, '76	“	1	....
166	....	Chætura pelagica, Bd	M.	“	“	“	July 10, '76	July 10, '76	“	1	....
167	....	Trochilus colubris, L.	....	“	“	“	1877	1877	C. L. Herrick	1	Presented
168	....	Ceryle alcyon, Boie	....	“	“	“	Aug. 1, 1876	Aug. 1, 1876	Geol. & N. H. Sur.	1	....
169	....	Coccygus erythophthalmus, Bd	M.	“	“	“	July 17, '78	July 17, '78	“	1	....
170	....	Coccygus erythophthalmus, Bd	F.	“	“	“	June 5, 1875	1876	C. L. Herrick	1	Presented
171	....	Picus pubescens, L.	M.	“	“	“	Aug. 14, '76	Aug. 14, '76	Geol. & N. H. Sur.	1	....
172	....	Picus pubescens, L.	M.	“	“	“	Aug. 18, '76	Aug. 18, '76	“	1	....
173	....	Picus pubescens, L.	....	“	“	“	....	....	....	1	....
174	....	Sphyrapicus varius (L.) Bd.	M.	Champlin	“	“	July 5, 1875	1876	C. L. Herrick	1	Presented
175	....	Melanerpes erythrocephalus, (L.) Sw	M	Minneapolis	“	“	Aug. 28, '76	Aug. 28. '76	Geol. & N. H. Sur.	1	....
176	....	Melanerpes erythrocephalus, (L.) Sw	M.	“	“	“	“	“	“	1	Young
177	....	Colaptes auratus, (L.) Sw	....	“	“	“	Apr. 29, '75	1876	C. L. Herrick	1	Presented
178	....	Colaptes auratus, (L.) Sw	M.	“	“	“	Aug. 28, '76	Aug. 28, '76	Geol. & N. H. Sur.	1	....
179	....	Bubo virginianus, (Gm.) Bon	....	“	“	“	Nov., 1876	Nov., 1876	C. L. Herrick	1	Presented
180	....	Falco sparverius, L.	....	“	“	“	Aug. 2, 1876	Aug. 2, 1876	Geol. & N. H. Sur.	1	....
181	....	Falco sparverius, L.	....	“	“	“	Aug. 13, '75	1876	C. L. Herrick	1	Presented
182	....	Buteo borealis, (Gm.) Vieil (?)	....	S. W. Minnesota	“	“	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	....
183	....	Buteo pennsylvanicus, (Wils.) Bon.	M.	Minneapolis	“	“	July 8, 1878	July 8, 1878	“	1	....
184	....	Ectopistes migratorius, Sw.	....	“	“	“	July 11, '76	July 11, '76	“	1	....
185	....	Ectopistes migratorius, Sw.	M.	“	“	“	July, 1876	July, 1876	“	1	....
186	....	Bonasa umbellus, (L.) Steph.	....	“	“	“	“	“	“	1	....
187	....	Bonasa umbellus, (L.) Steph	....	S. W. Minnesota	“	“	Oct., 1877	Oct., 1877	“	1	....
188	....	Aegialitis vociferus, L.	....	Minneapolis	“	“	July 22, '76	July 22, '76	“	1	....
189	....	Aegialitis vociferus, L.	....	“	“	“	July 19, '78	July 19, '78	“	1	....
190	....	Macrochampus griseus, (Gm.) Leach	....	Currie, Minn.	“	“	Oct., 1877	Oct., 1877	“	1	....
191	....	Totanus solitarius, Wils.	M.	Minneapolis	“	“	Aug. 12, '76	Aug. 12, '76	“	1	....

192	....	Totanus solitarius, Wils.	....	Minneapolis	Skin	C. L. Herrick	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	....
193	....	Totanus solitarius, Wils.	M.	"	"	"	Aug. 12, '76	Aug. 12, '76	"	1	....
194	....	Tringoides macularius, (L.) Gray	M.	"	"	"	July 14, '76	July 14, '76	"	1	....
195	....	Tringoides macularius, (L.) Gray	....	"	"	"	Oct. 4, '76	Oct. 4, 1876	"	1	....
196	....	Actiturus bartramius, (Wils.) Bon.	F.	"	"	"	June 12, '76	June 12, '76	"	1	....
197	....	Actiturus bartramius, (Wils.) Bon.	....	"	"	"	Aug. 6, 1875	1876	C. L. Herrick	1	Presented
198	....	Ardea herdodias, (Bt.) Coues	....	L. Minnetonka	"	"	Aug., 1878	Aug., 1878	Geol. & N. H. Sur.	1	....
199	....	Botaurus mugitans, (Bt.) Coues	....	Minneapolis	"	"	1875	1876	C. L. Herrick	1	Presented
200	....	Porzana carolina, (L.) V.	....	"	"	"	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	....
201	....	Fulica americana, Gm.	....	Currie, Murray Co.	"	"	Oct., 1877	Oct., 1877	"	1	....
202	....	Fulica americana, Gm.	....	"	"	"	"	"	"	1	....
203	....	Anser hyperboreus Pallas	....	"	"	"	"	"	"	1	....
204	....	Aix sponsa, (L.) Boie	M.	"	"	"	"	"	"	1	....
205	....	Querquedula discors, (L.) Steph.	....	"	"	"	"	"	"	1	....
206	....	Fuligula ferina, var. americana, Eyton	M.	"	"	"	"	"	"	1	....
207	....	Fuligula ferina, var. americana, Eyton	....	"	"	"	"	"	"	1	....
208	....	Fulignia ferina, var. americana, Eyton	F.	"	"	"	"	"	"	1	....
209	....	Fuligula ferina, var. americana, Eyton	F.	"	"	"	"	"	"	1	....
210	....	Spatula clypeata, (L) Boie	F.	"	"	"	"	"	"	1	....
211	....	Mareca americana, (Gm.) Steph.	F.	"	"	"	"	"	"	1	....
212	....	Chaulelasmus streperus, (L.) Gray	F.	"	"	"	"	"	"	1	....
213	....	Anas boschas, L.	M.	"	"	"	"	"	"	1	....
214	....	Lophodytes cucullatus, (L.) Rich.	....	Minneapolis	"	"	Nov., 1877	Nov., 1877	"	1	....
215	....	Graculus dilophus, (Sw.) Gray	....	Currie	"	"	Oct., 1877	Oct., 1877	"	1	....
216	....	Thalasseus caspius, Boie	M.	Long Lake	"	Will. Secomb	Nov., 1877	Nov., 1877	Will. Secomb	1	Presented
217	....	Larus delewarensis, Ord	....	Currie	"	C. L. Herrick	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	Young
218	....	Hydrochelidon lariformis, L.	M.	Minneapolis	"	"	July 19, '76	July 19, '76	"	1	....
219	....	Hydrochelidon lariformis, L.	....	"	"	"	"	"	"	1	Young
220	....	Podilymbus podiceps, (L.) Law.	....	Currie	"	"	Oct., 1877	Oct., 1877	"	1	....
221	....	Bubo virginianus, Bon.	....	L. Minnetonka	"	"	Aug., 1878	Aug., 1878	"	1	Young
222	1	Ampelis cedrorum, Vieill.	M.	Grand Marais	"	T. S. Roberts	July 28, '79	July 28, '79	"	1	....
223	2	Totanus solitarius, Wilson	F.	"	"	"	"	"	"	1	....
224	3	Melospiza melodia, (Wils.) Bd.	M.	"	"	"	"	"	"	1	....
225	4	Tringa minutilla, Vieill.	M.	"	"	"	"	"	"	1	....
226	5	Tringa minutilla, Vieill.	F.	"	"	"	"	"	"	1	....
227	6	Totanus flavipes, Gm.	M.	"	"	"	"	"	"	1	....
228	7	Dendrœca virens, (Gm.) Bd.	F.	"	"	"	"	"	"	1	....
229	8	Totanus solitarius, Wils.	M.	"	"	"	"	"	"	1	....
230	9	Totanus flavipes, Gm.	F.	"	"	"	"	"	"	1	....
231	10	Totanus flavipes, Gm.	M.	"	"	"	"	"	"	1	....
232	11	Chrysomitris pinus, (Wils.) Bon.	M.	"	"	"	July 29, '79	July 29, '79	"	1	....
233	12	Ampelis cedrorum, (Vieill.) Bd.	M.	"	"	"	July 30, '79	July 30, '79	"	1	....
234	13	Ampelis cedrorum, (Vieill.) Bd.	F.	"	"	"	"	"	"	1	....
235	14	Ampelis cedrorum, (Vieill.) Bd.	M.	"	"	"	"	"	"	1	....

Zoological Accessions to the Museum—Continued.

Catelogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
236	15	Zonotrichia albicollis, (Gm.) Bon.	M.	Grand Marais	Skin	T. S. Roberts	July 30, '79	July 30, '79	Geol. & N. H. Sur.	1	......
237	16	Picus pubsecens L.	F.	"	"	"	"	"	"	1	......
238	17	Ampelis cedrorum, (Vieill) Bd.	....	"	"	"	"	"	"	1	......
239	18	Ectopistes migratorius, (L.) Sw.	M.	"	"	"	"	"	"	1	......
240	19	Molothrus ater,"(Bodd.) Gray	....	"	"	"	"	"	"	1	......
241	20	Spizella socialis, (Wils.) Bon.	M.	"	"	"	"	"	"	1	......
242	21	Dendrœca maculosa, (Gm.) Bd.	....	"	"	"	"	"	"	1	......
243	22	Trochilus colubris, L.	....	"	Alc'hol	"	"	"	"	1	......
244	23	Loxia curvirostra, L.	M.	Poplar River	Skin	"	Aug. 8, 1879	Aug. 8, 1879	"	1	......
245	25	Myiodioctes canadensis, (L.) Aud.	F.	"	"	"	Aug. 4, 1877	Aug. 4, 1879	"	1	......
246	26	Myiodioctes canadensis, (L.) Aud.	....	"	"	"	"	"	"	1	......
247	27	Porzana carolina, (L.) V.	M.	"	"	"	Aug. 5, 1879	Aug. 5, 1879	"	1	......
248	28	Zonotrichia albicollis, (Gm.) Bon.	M.	"	"	"	"	"	"	1	Young.
249	29	Dendrœca cerulescens, (L.) Bd	M.	"	"	"	Aug. 6, 1879	Aug. 6, 1879	"	1	......
250	30	Dendrœca corulescens, (L.) Bd	M.	"	"	"	"	"	"	1	......
251	31	Empidonax flaviventris, Bd.	F.	"	"	"	"	"	"	1	......
252	32	Empidonax flaviventris, Bd.	....	"	"	"	"	"	"	1	......
253	33	Dendrœca maculosa, (Gm.) Bd.	....	"	"	"	"	"	"	1	......
254	34	Myiodioctes canadensis, (L.) And	M.	"	"	"	"	"	"	1	......
255	35	Parus atricapillus L.	....	"	"	"	Aug. 5, 1879	Aug. 5, 1879	"	1	......
256	36	Dendrœca blackburniæ, (Gm.) Bd.	F.	Grand Marais	"	"	Aug. 9, 1879	Aug. 9, 1879	"	1	......
257	37	Setophaga ruticilla, (L.) Sw.	M.	"	"	"	"	"	"	1	......
258	38	Dendrœca blackburniæ, (Gm.) Bd.	F.	"	"	"	"	"	"	1	Young.
259	39	Zonotrichia alcicollis, (Gm.) Bon	....	"	"	"	"	"	"	1	......
260	40	Ectopistes migratorius, (L.) Sw.	F.	"	"	"	"	"	"	1	......
261	41	Loxia curvirostra, L.	M.	"	"	"	Aug. 5, 1879	Aug. 5, 1879	"	1	......
262	42	Loxia curvirostra, L.	M.	"	"	"	Aug. 11, '79	Aug. 11, '79	"	1	......
263	43	Loxia curvirostra, L.	M.	"	"	"	Aug. 12, '76	Aug. 12, '79	"	1	......
264	44	Loxia curvirostra, L.	F.	"	"	"	"	"	"	1	......
265	45	Chrysometris pinus, (Wils.) Bon	F.	"	"	"	"	"	"	1	......
266	46	Larus argentatus, (Wils.) Bon.	M.	"	"	"	"	"	"	1	Young.
267	47	Loxia curvirostra, L.	M.	"	"	"	"	....	"	1	......
268	48	Falco columbarius, L.	....	"	"	"	Aug. 13, '79	Aug. 13, '79	"	1	......

269	49	Coccygus erythrophthalmus(Wil)Bd	M.	Grand Marais.....	Skin...	T. S. Roberts....	Aug. 13, '79	Aug. 13, '79	Geol. & N. H. Sur.	1	....
270	50	Helminthophaga peregrina (Wils) Bon, ...	M.	“	“ ...	“	“	“	“	1	....
271	51	Myiodioctes canadensis (L.) And...	....	“	“ ...	“	“	“	“	1	....
272	52	Perissoglossa tigrina, (Gen.) Bd.....	....	“	“ ...	“	“	“	“	1	....
273	53	Helminthophaga peregrina (Wil) Cab	....	“	“ ...	“	“	“	“	1	....
274	54	Dendrœca virens, (Gm.) Bd........	....	“	“ ...	“	“	“	“	1	....
275	55	Spizella socialis (Wils.) Bon.........	M.	“	“ ...	“	“	“	“	1	....
276	56	Spizella socialis. (Wils.) Bon.........	M.	“	“ ...	“	“	“	“	1	....
277	57	Melospiza melodia, (Wils.) Bd......	M.	“	“ ...	“	Aug. 12, '79	Aug. 12, '79	“	1	....
278	58	Melospiza melodia, (Wils.) Bd......	M.	“	“ ...	“	Aug. 13, '79	Aug. 13, '79	“	1	....
279	59	Seiurus nævius (Coues)...............	M.	Devils Track Lake	“ ...	“	Aug. 10, '79	Aug. 10, '79	“	1	....
280	60	Dendroeca castanea, (Wils.) Bd	F.	“	“ ...	“	Aug. 11, '79	Aug. 11, '79	“	1	....
281	61	Dendroeca coronata, (L.) Gray	F.	“	“ ...	“	Aug. 16, '79	Aug. 16, '79	“	1	....
282	62	Helminthophaga peregrina (Wil.) Bd	....	“	“ ...	“	“	“	“	1	....
283	63	Bonasa umbellus (L.) Steph....	M.	“	“ ...	“	“	“	“	1	....
284	64	Seurus nævius, Cones....	F.	“	“ ...	“	“	“	“	1	....
285	65	Seurus nævius, Cones	M.	“	“ ...	“	Aug. 18, '79	Aug. 18, '79	“	1	....
286	66	Dendrœca blackburniæ (Gen.) Bd..	M.	“	“ ...	“	“	“	“	1	....
287	67	Helminthophaga ruficapilla(Wils) Bd	F.	“	“ ...	“	“	“	“	1	....
288	68	Helminthophaga perigrina (Wils) Bd	....	“	“ ...	“	“	“	“	1	....
289	69	Loxia curvirostra, L..................	F.	Grand Marais.....	“ ...	“	“	“	“	1	....
290	70	Loxia curvirostra, L..................	F.	“	“ ...	“	“	“	“	1	....
291	71	Loxia curvirostra, L..................	M.	“	“ ...	“	“	“	“	1	....
292	72	Troglodytes ædon, Vieill.............	....	“	“ ...	“	Aug. 19, '79	Aug. 19, '79	“	1	....
293	73	Aegeleus phœniceus (L.) V...........	F.	“	“ ...	“	“	“	“	1	....
294	74	Helminthophaga peregrina (Wils) Bd	....	“	“ ...	“	“	“	“	1	....
295	75	Aegeleus phœniceus (L.) V...........	....	“	“ ...	“	“	“	“	1	....
296	76	Spizella socialis, (Wils.) Bon.........	F.	“	“ ...	“	“	“	“	1	....
297	77	Falco sparverius, L..................	F.	“	“ ...	“	“	“	“	1	....
298	78	Coccygus erythrophthalmus (Wil) Bd	M.	“	“ ...	“	“	“	“	1	....
200	79	Larus delawarensis, Ord.............	....	“	“ ...	“	“	“	“	1	....
300	80	Buteo pennsylvanicus, (Wils.) Bon.	....	“	“ ...	“	“	“	“	1	....
301	81	Falco sparverius, L..................	M.	“	“ ...	“	“	“	“	1	....
302	82	Falco sparverius, L..................	M.	“	“ ...	“	“	“	“	1	....
303	83	Contopus borealis, (Sw.) Bd..........	....	“	“ ...	“	Aug. 20, '79	Aug. 29, '79	“	1	....
304	84	Tyrannus carolinensis (L.) Bd	M.	“	“ ...	“	“	“	“	1	....
305	85	Contopus borealis (Sw.) Bd...........	M.	“	“ ...	“	“	“	“	1	....
306	86	Sayornis fuscus, (Gen.) Bd	F.	“	“ ...	“	“	“	“	1	....
307	87	Empidcnax minimus, Bd	F.	“	“ ...	“	“	“	“	1	....
308	88	Tyrannus carolinensis, (L.) Bd......	F.	“	“ ...	“	“	“	“	1	....
309	89	Contopus borealis, (Sw.) Bd,.........	M.	“	“ ...	“	“	“	“	1	....

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When	Whence.		
310	91	Contopus borealis, (Sw.) Bd	F.	Grand Marais	Skin	T. S. Roberts	Aug. 20, '79	Aug. 20, '79	Geol. & N. H. Sur.	1	
311	92	Contopus borealis, (Sw.) Bd		"	"	"	"	"	"	1	
312	93	Chrysomitris pinus, (Wils.) Bon	M.	"	"	"	"	"	"	1	
313	94	Picus villosus, L	F.	"	"	"	"	"	"	1	
314	95	Picoides arcticus, (Sw.) Gray	F.	"	"	"	Aug. 21, '79	Aug. 21, '79	"	1	
315	96	Bubo virginianus, (Gm.) Bon	F.	"	"	"	Aug. 20, '79	Aug. 20, '79	"	1	
316	97	Helminthophaga perigrina, (Wils) Cab	F.	"	"	"	"	"	"	1	
317	98	Helminthopaga perigrina, (Wils) Cab	F.	"	"	"	"	"	"	1	
318	99	Picus pubescens, L	M.	"	"	"	"	"	"	1	
319	100	Contopus borealis, (Sw.) Bd	M.	"	"	"	"	"	"	1	
320	101	Picus pubescens, L	M.	"	"	"	"	"	"	1	
321	102	Falco sparverius, L	F.	"	"	"	"	"	"	1	
322	103	Anas boschas, L	F.	Devil's Track R.	"	"	"	"	"	1	
323	104	Trigan semipalmata	F.	"	"	"	Aug. 21, '79	Aug. 21, '79	"	1	
324	105	Ampelis cedrorum, (Vieill.) Bd	F.	"	"	"	"	"	"	1	
325	106	Tringa bairdii, (?)		Grand Marais	"	"	Aug. 22, '79	Aug. 22, '79	"	1	
326	107	Tringa bairdii, (?)	F.	"	"	"	"	"	"	1	
327	108	Loxia curvirostra, L	M.	"	"	"	Aug. 23, '79	Aug. 23, '79	"	1	
328	109	Loxia curvirostra, L	F.	"	"	"	"	"	"	1	
329	111	Myiodioctes pusillus, (Wils.) Bon	M.	Beaver Bay	"	"	Aug. 27, '79	Aug. 27, '79	"	1	
330	112	Empidonax traillii, (Aud.) Bd		"	"	"	"	"	"	1	
331	113	Dendrœca striata, (Forst.) Bd	F.	"	"	"	"	"	"	1	
332 333	114	Heliminthophaga ruficapilla, (Wils.) Bd		"	"	"	"	"	"	1	
	115	Dendrœca palmarum, (Gm.) Bd	F.	"	"	"	"	"	"	1	
334	116	Dendræca maculosa, (Gm.) Bd		"	"	"	"	"	"	1	
335	117	Heliminthopaga peregrina, (Wils) Cab		"	"	"	"	"	"	1	
336	118	Porzana carolina, L		"	"	"	"	"	"	1	
337	119	Astor palumbarius, L., var. atricapillus, (Wils.) Coues		Little Marais	"	"	Aug. 26, '79	Aug. 26, '79	"	1	Young of the year

338	120	Helminthophaga ruficapilla (Wil.) Bd.	....	Beaver Bay	Skin	T. S. Roberts	Aug. 28, '79	Aug. 28, '79	Geol. & N. H. Sur.	1	....
339	121	Vireosylvia olivacea, (L.) Bon	....	"	"	"	"	"	"	1	....
340	122	Lobipes hyperboreus (L.) Cur	F.	Near Beaver Bay	"	N. H. Winchell	Aug. 29, '79	Aug. 29, '79	"	1	....
341	123	Aegeleus phœniceus (L.) V	M.	Beaver Bay	"	T. S. Roberts	"	"	"	1	....
342	124	Colaptes auratus, (L.) Sw	F.	Duluth, Minn	"	"	Sept. 1, 1879	Sept. 1, 1879	"	1	....
343	125	Tringordes macularius, (L.) Gray	....	"	"	"	"	"	"	1	....
344	126	Chordeiles virginianus, (Gm.) Bon.	F.	"	"	"	"	"	"	1	....
345	127	Corvus americanus	M.	"	"	"	"	"	"	1	....
346	128	Falco sparverius, L	....	"	"	"	"	"	"	1	....
347	129	Melospiza melodia, (Wils.) Bd	....	"	"	"	"	"	"	1	....
348	....	Haliaetus leucocephalus (L.) Savigny	....	....	M'td	....	....	....	"	1	In rustic case
349	....	Buteo borealis (Gm.) Vieill	....	Hopkin's Station	"	C. L. Herrick	July 1876	July, 1876	"	1	"
350	....	Falco sparverius, L	....	Minneapolis	"	"	"	"	"	....	"
351	....	Corvus corax, L	....	"	"	N. Herrick	"	"	"	....	"
352	....	Dolichonyx oryzivorus, (L.) Sw	M.	"	"	B. L. Herrick	"	"	"	....	"
353	....	Dolichonyx oryzivorus	F.	"	"	"	"	"	"	....	"
354	....	Botarus mugitans, (Bart.) Coues	....	"	"	"	"	"	"	....	"
355	....	Tringoides macularius, (L.) Gray	....	"	"	"	"	"	"	....	"
356	....	Totanus solitarius, Wils	....	"	"	"	"	"	"	....	"
357	....	Scolopax rusticola, L	....	"	"	"	"	"	"	....	"
358	....	Sturnella magna, (L.) Sw	....	"	"	"	"	"	"	....	"
359	....	Melothrus ater, (Bodd.) Gray	M.	"	"	"	"	"	"	....	"
360	....	Seiurus auricapillus, (L.) Sw	....	"	"	"	"	"	"	....	"
361	....	Vireosylvia olivacea, (L.) Bon	....	"	"	"	"	"	"	....	"
362	....	Helminthophaga ruficapilla (?)	....	"	"	"	"	"	"	....	"
363	....	Cotyle riparia, (L.) Boie	....	"	"	"	"	"	"	....	"
364	....	Melospiza melodia, (Wils.) Bd	....	"	"	"	"	"	"	....	"
365	....	Melanerpes erythrocephalus (L.) Sw	....	"	"	"	"	"	"	....	"
366	....	Colaptes auratus, (L.) Sw	....	"	"	"	"	"	"	....	"
367	....	Chætura pelagica, (L.) Sw	....	"	"	"	"	"	"	....	"
368	....	Hydrochelidon lariformis (L) Coues	....	"	"	"	"	"	"	....	"
369	....	Spizella pallida, (Sw.) Bon	....	"	"	"	"	"	"	....	"
370	....	Seiurus aurocapillus, (L.) Sw	....	"	"	"	"	"	"	....	"
371	....	Vireosylvia olivacea, (L.) Bon	....	"	"	"	"	"	"	....	"
372	....	Eremophila alpestris, Boie	....	"	"	"	"	"	"	....	"
373	....	Pocetes gramineus, (Gray) Bd	....	"	"	"	"	"	"	....	"
374	....	Harporhynchus rufus	....	"	"	"	"	"	"	....	"
375	....	Icterus spurius, (L.) Bon	....	"	"	"	1876	1876	"	....	"
376	....	Cyanospiza cyanea, (L.) Bd	M.	"	"	"	1876	1876	"	....	"
377	....	Tyrannus carolinensis (L.) Bd	....	"	"	"	1876	1876		....	"
378	....	Goniaphea ludoviciana (L.) Board	....	"	"	"	1276	1876	"	....	"
379	....	Chordeiles virginianus, (Gm.) Bon.	....	"	"	"	1876	1876	"	....	"
380	....	Icterus baltimore, (L.) Dandin	....	"	"	"	1876	1876	"	....	"
381	....	Hylocichla swainsoni (Cab) Bd	....	"	"	"	1870	1876	"	....	"
382	....	Ectopistes migratorius	....	"	"	"	1879	1876	"	....	"
383	....	Sialia sialis, (L.) Haldeman	....	"	"	"	1876	1876	"	....	"
384	....	Galeoscoptes carolinensis, (L.) Cab.	....	"	"	"	1876	1876	"	....	"

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality	Nature of Specimen.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
385	....	Dendrœca æstiva, (Gm.) Bd	....	Minneapolis	M'td	C. L. Herrick	1876	1876	Geol. & N. H. Sur.	1	In rustic case,
386	....	Goniaphea ludoviciana, (L.) Bowd	M.	"	"	"	1876	1876	"	1	"
387	....	Goniaphea ludoviciana, (L.) Bowd.	F.	"	"	"	1876	1876	"	1	"
388	....	Euspiza americana, (Gm.) Bd	....	"	"	"	1876	1876	"	1	"
389	....	Pyranga rubra, (L.) Vieill	M.	"	"	"	1876	1876	"	1	"
390	....	Collurio ludovicianus, L	....	"	"	"	1876	1876	"	1	"
392	....	Ammodromus passerinus, (Wils) Bd	....	"	"	"	1876	1876	"	1	"
392	....	Aquila chrysætus, L	....	Grand Marais	"	H. Mayhew	1877	1879	H. Mayhew	1	Presented.
393	....	Podilymbus podiceps	F.	....	"	C. W. Hall	'Sept., 1878	1878	Geol. & N. H. Sur.	1	....
394	....	Pelecanus trachyrhynchus, Lath	M.	....	"	....	....	....	....	1	....
395	....	Pelecanus trachyrhynchus, Lath	F.	....	"	....	....	....	....	1	....
396	....	Rhinogryphus aura, (L.) Ridg	F.	Grand Marais	"	C. W. Hall	1878	1878	Geol. & N. H. Sur.	1	....
367	....	Grus canadensis, (L.) Temm	M.	Medicine Lake	"	E. Moulton	1878	1880	Wm. Howling	1	By purchase.
398	....	Grus canadensis, (L.) Temm	F.	Lake Minnetonka.	"	P. M. Babcock	1879	1880	"	1	"
399	....	Larus argentatus, Brünn	....	Grand Marais	"	S. F. Peckham	1879	1879	Geol. & N. H. Sur.	1	....
400	....	Ampelis garrulus, L	M.	Minneapolis	"	T. S. Roberts	Feb., 1880	1880	T. S. Roberts	1	Presented.!
401	....	Ampelis garrulus, L	F.	"	"	"	"	1880	"	1	"
402	....	Accipiter fuscus, (Gm.) Bon	M.	Lake Minnetonka.	"	Wm. Howling,	....	May, 3,1880	Mr. Howling	1	"
403	....	Accipiter fuscus, (Gm.) Bon	F.	Minneapolis	"	J. W. Pomeroy	Jan., 1880	1880	J. W. Pomeroy	1	....
404	....	Falcc sparverius, L	....	Grand Marais	"	C. W. Hall	Sept., 1878	1878	Geol. & N. H. Sur.	1	....
405	....	Harporhynchus rufus	....	Minneapolis	"	C. L. Herrick	July, 1879	July, 1879	C. L. Herrick	1	By purchase.
406	....	Chordeiles virgineanus, (Gm.) Bon.	F.	"	"	"	"	"	"	1	"
407	....	Coccygus americanus, (L.) Bon	....	"	"	"	"	"	"	1	"
408	....	Icterus spurius, (L.) Bon	M.	"	"	"	"	"	"	1	Young.
409	....	Scolecophagus ferrugineus,(Gm) Sw	M.	"	"	"	"	"	"	1	"
410	....	Ceryle alcyon, (L.) Boie	....	"	"	"	"	"	"	1	"
411	....	Xanthocephalus icterocephalus, (Bon.) Bd	M.	"	"	"	"	"	"	1	"
412	....	Aegelaeus phœniceus, (L.) V	M.	"	"	"	"	"	"	1	"
413	....	Colaptes auratus, (L.) Sw	....	"	"	"	"	"	"	1	"
414	....	Poœtes gramineus, (Gray) Bd	....	"	"	"	"	"	"	1	"
415	....	Poœtes gramineus, (Gray) Bd	....	"	"	"	"	"	"	1	"

416	Tongue of dog		Minneapolis	Alc'hol	C. W. Hall	1879	1879	Geol. & N. H. Sur.	1	
417	Larynx and hyoid bone of dog		"	"	"	1879	1879	"	1	
418	Heart and connecting vessels of dog		"	"	"	1879	1879	"	1	
419	Lungs and trachea of dog		"	"	"	1879	1879	"	1	
420	Heart of duck--billed cat fish		"	"	"	1880	1880	"	1	
421	Gizzard of Bonasa umbellus		"	"	"	1879	1879	"	1	
422	Gizzard of owl		"	"	"	1879	1879	"	1	
423	Heart of lake trout		"	"	"	1879	1879	"	1	
424	Heart of Bonasa umbellus		"	"	"	1879	1879	"	1	
425	Egg of turtle		"	"	N. H. Winchell.	1879 (?)	1879 (?)	"	1	
426	Woodpecker's tongue		"	"	C. W. Hall	1879	1879	"	1	
427	Tongue of mallard duck		"	"	"	1879	1879	"	1	
428	Pelican's sterna and trachea		New Ulm	"	Mr. Howling	Apr. 20, '80	Apr. 20, '80	Wm. Howling	2	
429	Humeri ulnæ and tibiæ of pelican		"	"	"	"	"	"	6	
430	Skull of Canis		Minneapolis	Mt'd	C. L. Herrick	1879	1879	C. L. Herrick	1	Presented
431	Skull of Felis		"	"	"	1879	1879	"	1	"
432	Pseudopleuronectes americanus, Gill		Manchester, Mass.	Alc'hol	C. W. Hall	July, 1880	1880	Geol. & N. H. Sur.	2	
433	Eutænia sirtalis, Bd. & G'rd	F.	Minneapolis	"	C. L. Herrick	July, 1879	July, 1879	C. L. Herrick	1	
434	Crotalus horridus, L.		Black Hills, Da.	"	N. H. Wincheil	1874	1874	Geol. & N. H. Sur.	1	Custer Exp
435	Pityophis sayi, Bd. & G'rd		"	"	"	1874	1874	"	1	"
436	Eutaenia sirtalis, Bd. & G'rd		"	"	"	1874	1874	"	1	"
437	Eutaenia sirtalis, Bd. & G'rd		Minneapolis	"	"			"	1	
438	Ophibolus doliatus, var. triangulus.		"	"	H. V. Winchell	1879	1879	"	1	
439	Aspidenectes spinifer, (Le S.) Ag.		"	"	T. S. Roberts	1879	1879	"	1	
440	Tropidonotus, s. p. ?		Lake Minnetonka.	"	W. H. Shenton	1880	1880	W. H. Shenton	1	
441	Tropidonotus, (?)		Minneapolis	"	C. L. Herrick	1877	1877	Geol. & N. H. Sur.	1	
442	Liopellis vernalis, Jar		Black Hills, Da.	"	N. H. Winchell	1874	1874	"	2	Custer Exp
443	Chrysemys picta, Ag	F.	Minneapolis	"	C. L. Herrick	1879	1879	C. L. Herrick	1	Viscera exposed
444	Tropidontus sipedon		"	"	"	July, 1877	1877	Geol. & N. H. Sur.	1	
445				"						Turtle
446				"						Turtle
447	Eutænia sirtalis, Bc. & G'rd. *		Black Hills, Da.	"	N. H. Winchell.	1870	1874	Geol. & N. H. Sur.	1	Custer Exp
448	Eutænia sirtalis, Bd. & G'rd,		"	"	"	1874	1874	"	2	"
449	Eutænia sirtalis, Bd. & G'rd		Minueapolis	"	C. L. Herrick	July, 1876	July, 1876	"	1	
450	Eutænia, s. p. ?		"	"	H. V. Winchell.	Aug., 1880	Aug., 1880	H. V. Winchell		
451	Plathodon erythronotus, (Green) Bd		Grand Marais	"	C. W. Hall	Aug., 1879	Aug., 1879	Geol. & N. H. Sur.	4	
452	Eutænia, s. p. ?		Black Hills, Da.	"	N. H. Winchell.	1874	1874	"	1	Custer Exp
453	Bufo lentinginosus, Shaw			"					1	
454	Bufo lentinginosus, Shaw			"					1	
455	Rana clamitans, Merr		Lake Minnetonka.	"	C. L. Herrick	Aug., 1878	Aug,, 1878	C. L. Herrick	1	
456	Rana halecina, Kalm			"					1	
457	Necturus, s. p ?			"					1	
458	Necturus maculatus		Minneapolis	"	N. H. Winchell.			Geol. & N. H. Sur.	1	
459	Rana clamitans, Merr		"	"	C. L. Herrick	1876	1876	"	1	
460	Rana halecina, Kalm		"	"	H. Nachtrieb	1878	1878	N. Nachtrieb	1	
461	Bufo lentiginosus, Shaw		"	"	C. L. Herrick	1877	1877	Geol. & N. H. Sur.	1	
462	Necturus lateratis, Say		"	"	N. H. Winchell.			"	1	

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
463	....	Rana halecina, Kalm	....	Minneapolis	Alc'hol	C. L. Herrick	1879	1879	C. L. Herrick	1	Alimentary ca-
464	....	Phrynosoma douglasi, Bell?	....	Dakota Ter	"	N. H. Winchell.	1874	1874	Geol. & N. H. Sur.	4	..[nal exposed
465	....	Amblystoma, (s. p. ?)	....	Minneapolis	"	C. L. Herrick	July, 1876	July, 1876	"	1	Immature
466	....	Amblystoma punctatum	....	"	"	N. H. Winchell.			"	Ind	
467	....		....	California	"	R. O. Sweeny	1880	1880	R. O. Sweeney	1	Horned toad,
468	....		....	New Mexico	"	N. H. Winchell.	1872		N. H. Winchell	1	" [presentd
469	....		....	"	"	"	1872		"	1	"
470	....		....	Minnetonka	"	C. L. Herrick	Aug., 1878	Aug., 1878	Geol. & N. H. Sur.	1	Frog
471	....	Rana halecina, Kalm	....	Minneapolis	"	H. V. Winchell.	Aug., 1880	Aug., 1880	H V, Winchell	1	
472	....		....	"	"	"	"	"	"	1	Frog
473	....	Amblystoma, sp. ?	....	"	"	"	"	"	"		
474	....		....	Black Hills	"	N. H. Winchell.	1874	1876	Geol. & N. H. Sur.	1	Custer Exp
475	....		....	California	"	Th. Croswell	1877	1877	Th. Croswell		Horned toad
476	....	Pimephales promelas, Raf	....	Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts		
477	....	Eupomotis aureus, (Walb.) G. & J.	....	"	"	"	July 6, 1879	"	"		
478	....	Pimephales promelas, Raf	....	"	"	"	July 10, '79	"	"		
479	....	Calostomistæ	....	Grand Marais	"	"			Geol. & N. H. Sur.		Young
480	....	Salvelinus frontinalis, (Mitch) G.&J	....	N. shore L. Sup	"	C. W. Hall	July, 1878	1878	"		
481	....	Pimephales promelas, Raf	....	Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts		
482	....	Boleichthys eos	....	"	"	"	Apr. 24, 79	"	"		
483	....	Hyborhynchus notatus	....	"	"	"	May 9, 1879	"	"		
484	....		....	"	"	"					
485	....	Ceratichthys biguttatus, (Kirk) Grd	....	"	"	"	June, 1879	July, 1879	T. S. Roberts		
486	....	Boleichthys eos	....	"	"	"	Apr. 24, '79	"	"		
487	....	Potamocottus alvordii, (Grd) Gill (?)	....	Grand Marais	"	"	Aug., 1879	Aug., 1879	Geol. & N. H. Sur.		
488	....	Pimephales promelas, Raf	....	Minneapolis	"	"	July 10, '79	July, 1879	T. S. Roberts		
489	....	Canutus luxilus, (Mitch.) Jor	....	"	"	"	Apr. 24, '79	"	"		
490	....	Fundulus diaphanes	....	"	"	"	May 1, 1879	"	"	2	
491	....	Bolesoma maculata, Ag	....	Basset's Cr., Minne	"	"	July 4, 1879	"	"	6	
492	....	Pygosteus occidentalis, var. nebulosus, (Ag.) Jor	....	Grand Marais	"	"	July 29, '79	"	Geol. & N. H. Sur.		
493	....	Hyodon tergisus, Le Sueur	....	Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers	2	...[Long Lake
494	....	Percina manitou, Jor	....	Ramsey Co	"	T. S. Roberts	Apr. 28, '79	Apr. 28, '79	T. S. Roberts	2	From a trib, of

495	....	Stizostethium vitreum, (Mitch) J. & C	....	Medicine Lake	Alc'hol	T. S. Rhodes	June 30, '79	1879	T. S. Roberts	....	
496	....	Pomoxys nigromaculatus, (Le S.) Grd	....	"	"	"	"	1879	"	....	
497	....	Cycleptus elongatus	....	Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers	....	
498	....	Acipenser rubicundus, Le S.	....	"	"	"	May, 1878	1878	"	....	
499	....	Leplopomus pallidus, (Mitch) G. & J	....	L. Minnetonka	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts	....	
500	....	Ceratichthys biguttatus, (Kirt) Gird.	....	Minneapolis	"	"	June 1, 1879	1879	"	....	
501	....	Semotilus corporalis, Mitch	....	"	"	"	June 28, '79	1379	"	....	
502	....	Amiurus melas, (Raf.) J. & C.	....	"	"	"	"	1879	"	....	
503	....	Amiurus melas (Raf.) J. & C.	....	"	"	"	"	1879	"	....	
504	....	Perca americana, Schr.	....	Medicine Lake	"	"	June 30, '79	1879	"	....	
505	....	Amblophilites rupestris (Raf.) Gill.	....	Minneapolis	"	"	June, 1879	1879	"	....	
506	....	Silurus amiurus, Pallus. (?)	....	"	"	C. L. Herrick	1876	1876	Geol. & N. H. Sur.	....	
507	....	Batrachus tau, Linn.	....	Virginia	"	Gov. Austin	1876	1876	Gov. Austin	....	
508	....	Otolitheus regalis	....	"	"	"	1876	1876	"	....	
509	....	Perca, sp. ?	....	"	"	"	1876	1876	"	....	
510	....	Prinothus, sp. ?	....	"	"	"	1876	1876	"	....	
511	....	Lepiopomus pallidus, (Mitch.) J. & G	....	Lake Minnetonka.	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts	....	
512	....	Poniotis auritus, L. ?	....	Minneapolis	"	C. L. Herrick	Aug. 12, '77	Aug. 12, '77	Geol. & N. H. Sur.	....	
513	....		....	Baptism R., Minn.	"	C. W. Hall	1878	1878	"	....	Fish
514	....		....	Gooseberry R, L.S.	"	"	1878	1878	"	....	
515	....	Stizostithium itreum (Mitch) J. & C	....	Minneapolis	"	"	May, 1880	1880	"	4	
516	....		....	Grand Marais	"	"	Apr., 1879	Aug., 1877	"	2	Fish
517	....		....	Out. Bass L, Minne	"	C. L. Herrick	June 13, '78	June 13, '78	"	....	Fish
518	....		....	Beav. Bay C'k, L.S	"	C. W. Hall	Aug. 29, '79	Aug. 29, '79	"	8	Fish
519	....	Percina manitou, Jor. ?	....	N. shore L. Supe.	"	"	1878	1878	"	1	
520	....	Salmo frontinalis, Mitch	....		"	C. M. Terry	Aug., 1879	1879	"	1	
521	....	Scaphirhynchops platyrhynchus, (Raf.) Gill	....	Minneapolis	"		1880	1880	"	1	Purchased
522	....	Cycleptus, sp. ?	....	"	"		1880	1880	"	1	"
523	....	Lepidosteus osseus, (L.) Ag.	....	"	"		1880	1880	"	3	"
524	....	Eggs of trout	....	St. Paul	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	Unimpregn't'd
525	....	Eggs of trout	....	"	"	"	1879	1879	"	"	Imp. 6 dy's old
526	....	Eggs of trout	....	"	"	"	1879	1879	"	"	20 days old
527	....	California salmon	....	"	"	"	1879	1879	"	"	2 weeks old
528	....	California salmon	....	"	"	"	1879	1879	"	"	3 weeks old
529	....	California salmon	....	"	"	"	1879	1879	"	2	Young frog
530	....	California salmon	....		"	"	1879	1879	"	1	Yearling
531	....	Lake trout	....		"	"	1879	1879	"	2	Young fry
532	....	Brook trout	....		"	"	1879	1879	"	1	Yearling
533	....	Lake trout	....		"	"	1879	1879	"	Ind	1 week old
534	....	Hyodon tergisus, Le S.	....	Minneapolis	"	C. W. Hall	1880	1880	Geol. & N. H. Sur.	1	Viscara exp'sd
535	....	Stizostethium vitreum, Mitch.	....	"	"	"	1880	1880	"	1	"
536	....	Acipenser rubicundus	....	"	"	"	1879	1879	"	1	Heart
537	....	Polyodon folium, Lac.	....	"	"	W. H. Holden	May, 1880	1880	W. H. Holden	1	
538	....	Anguilla rostrata	....	"	"		May 20, '80	1880	Wm. Howling	1	
539	....		....	"	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	3 weeks old

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
463	....	Rana halecina, Kalm		Minneapolis	Alc'hol	C. L. Herrick	1879	1879	C. L. Herrick	1	Alimentary ca-
464	....	Phrynosoma douglasi, Bell?		Dakota Ter.	"	N. H. Winchell.	1874	1874	Geol. & N. H. Sur.	4	..[nal exposed
465	....	Amblystoma, (s. p. ?)		Minneapolis	"	C. L. Herrick	July, 1876	July, 1876	"	1	Immature
466	....	Amblystoma punctatum		"	"	N. H. Winchell.			"	Ind	
467	....			California	"	R. O. Sweeny	1880	1880	R. O. Sweeney	1	Horned toad,
468	....			New Mexico	"	N. H. Winchell.	1872		N. H. Winchell	1	" [presentd
469	....			"	"	"	1872		"	1	"
470	....			Minnetonka	"	C. L. Herrick	Aug., 1878	Aug., 1878	Geol. & N. H. Sur.	1	Frog
471	....	Rana halecina, Kalm		Minneapolis	"	H. V. Winchell.	Aug., 1880	Aug., 1880	H V, Winchell	1	
472	....			"	"	"	"	"	"	1	Frog
473	....	Amblystoma, sp. ?		"	"	"	"	"	"		
474	....			Black Hills	"	N. H. Winchell.	1874	1876	Geol. & N. H. Sur.	1	Custer Exp
475	....			California	"	Th. Croswell	1877	1877	Th. Croswell	....	Horned toad
476	....	Pimephales promelas, Raf		Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts	....	
477	....	Eupomotis aureus, (Walb.) G. & J.		"	"	"	July 6, 1879	"	"	....	
478	....	Pimephales promelas, Raf		"	"	"	July 10, '79	"	"	....	
479	....	Calostomistæ		Grand Marais	"	"			Geol. & N. H. Snr.	....	Young
480	....	Salvelinus frontinalis, (Mitch) G.&J		N. shore L. Sup.	"	C. W. Hall	July, 1878	1878	"	....	
481	....	Pimephales promelas, Raf		Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts	....	
482	....	Boleichthys eos		"	"	"	Apr. 24, 79	"	"	....	
483	....	Hyborhynchus notatus		"	"	"	May 9, 1879	"	"	....	
484	....			"	"	"				....	
485	....	Ceratichthys biguttatus, (Kirk) Grd		"	"	"	June, 1879	July, 1879	T. S. Roberts	....	
486	....	Boleichthys eos		"	"	"	Apr. 24, '79	"	"	....	
487	....	Potamocottus alvordii, (Grd) Gill (?)		Grand Marais	"	"	Aug., 1879	Aug., 1879	Geol. & N. H. Sur.	....	
488	....	Pimephales promelas, Raf		Minneapolis	"	"	July 10, '79	July, 1879	T. S. Roberts	....	
489	....	Canutus luxilus, (Mitch.) Jor		"	"	"	Apr. 24, '79	"	"	....	
490	....	Fundulus diaphanes		"	"	"	May 1, 1879	"	"	2	
491	....	Bolesoma maculata, Ag.		Basset's Cr., Minne	"	"	July 4, 1879	"	"	6	
492	....	Pygosteus occidentalis, var. nebulosus, (Ag.) Jor.		Grand Marais	"	"	July 29, '79	"	Geol. & N. H. Sur.	....	
493	....	Hyodon tergisus, Le Sueur		Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers	2	...[Long Lake
494	....	Percina manitou, Jor		Ramsey Co.	"	T. S. Roberts	Apr. 28, '79	Apr. 28, '79	T. S. Roberts	2	From a trib. of

495	Stizostethium vitreum, (Mitch) J. & G.	Medicine Lake	Alc'hol	T. S. Rhodes	June 30, '79	1879	T. S. Roberts		
496	Pomoxys nigromaculatus, (Le S.) Grd	"	"	"	"	1879	"		
497	Cycleptus elongatus	Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers		
498	Acipenser rubicundus, Le S.	"	"	"	May, 1878	1878	"		
499	Lepiopomus pallidus, (Mitch) G. & J	L. Minnetonka	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts		
500	Ceratichthys biguttatus, (Kirt) Gird.	Minneapolis	"	"	June 1, 1879	1879	"		
501	Semotilus corporalis, Mitch	"	"	"	June 28, '79	1379	"		
502	Amiurus melas, (Raf.) J. & C.	"	"	"	"	1879	"		
503	Amiurus melas (Raf.) J. & C.	"	"	"	"	1879	"		
504	Perca americana, Schr	Medicine Lake	"	"	June 30, '79	1879	"		
505	Amblophilites rupestris (Raf.) Gill.	Minneapolis	"	"	June, 1879	1879	"		
506	Silurus amlurus, Pallus. (?)	"	"	C. L. Herrick	1876	1876	Geol. & N. H. Sur.		
507	Batrachus tau, Linn	Virginia	"	Gov. Austin	1876	1876	Gov. Austin		
508	Otolitheus regalis	"	"	"	1876	1876	"		
509	Perca, sp. ?	"	"	"	1876	1876	"		
510	Prinothus, sp. ?	"	"	"	1876	1876	"		
511	Lepiopomus pallidus, (Mitch.) J. & G	Lake Minnetonka.	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts		
512	Poniotis auritus, L. ?	Minneapolis	"	C. L. Herrick	Aug. 12, '77	Aug. 12, '77	Geol. & N. H. Sur.		
513		Baptism R., Minn.	"	C. W. Hall	1878	1878	"		Fish
514		Gooseberry R, L.S.	"	"	1878	1878	"		
515	Stizostithium vitreum (Mitch) J. & C	Minneapolis	"	"	May, 1880	1880	"	4	
516		Grand Marais	"	"	Apr., 1879	Aug., 1877	"	2	Fish
517		Out. Bass L, Minne	"	C. L. Herrick	June 13, '78	June 13, '78	"		Fish
518		Beav. Bay C'k, L.S	"	C. W. Hall	Aug. 29, '79	Aug. 29, '79	"	8	Fish
519	Percina manitou, Jor. ?	N. shore L. Supe.	"	"	1878	1878	"	1	
520	Salmo frontinalis, Mitch		"	C. M. Terry	Aug., 1879	1879	"	1	
521	Scaphirhynchops platyrhynchus, (Raf.) Gill	Minneapolis	"		1880	1880	"	1	Purchased
522	Cycleptus, sp. ?	"	"		1880	1880	"	1	"
523	Lepidosteus osseus, (L.) Ag.	"	"		1880	1880	"	3	"
524	Eggs of trout	St. Paul	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	Unimpregn't'd
525	Eggs of trout	"	"	"	1879	1879	"	"	Imp. 6 dy's old
526	Eggs of trout	"	"	"	1879	1879	"	"	20 days old
527	California salmon	"	"	"	1879	1879	"	"	2 weeks old
528	California salmon	"	"	"	1879	1879	"	"	3 weeks old
529	California salmon	"	"	"	1879	1879	"	2	Young frog
530	California salmon		"	"	1879	1879	"	1	Yearling
531	Lake trout		"	"	1879	1879	"	2	Young fry
532	Brook trout		"	"	1879	1879	"	1	Yearling
533	Lake trout		"	"	1879	1879	"	Ind	1 week old
534	Hyodon tergisus, Le S.	Minneapolis	"	C. W. Hall	1880	1880	Geol. & N. H. Sur.	1	Viscara exp'sd
535	Stizostethium vitreum, Mitch	"	"	"	1880	1880	"	1	"
536	Acipenser rubicundus	"	"	"	1879	1879	"	1	Heart
537	Polyodon folium, Lac	"	"	W. H. Holden	May, 1880	1880	W. H. Holden	1	
538	Anguilla rostrata	"	"		May 20, '80	1880	Wm. Howling	1	
539		"	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	3 weeks old

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
540	.....	Amiurus vulgaris, var. ælurus, (G'rd.) Jor.		Lake Minnetonka.	Alc'hol	T. S. Roberts	July 8, 1879	July, 1879	T. S. Roberts	1	
541	14828	Tetrodon turgidus, Mitch.		Noank, Con.	"	U. S. Fish Com.		Sept., 1880	U. S. Nat. Museum		
542	16567	Alutera schoepfii, (Wall.) G. & B.		Wood's Holl, Mass	"	"		"	"		
543	18946	Monacanthus setifer, Bennett.		"	"	"		"	"		
544	23162	Gasterosteus aculeatus, L.		"	"	"		"	"		
545	13404	Apeltes quadracus, (Mitch) Brevoort		" [Glouc. M's	"	"		"	"		
546	22691	Limanda ferruginea, (Storer) G. & B		Minh. Id. Trap,	"	"		"	"		
547	20003	Pleuronectes glaber, (Storer) Gill.		Wash. Market	"	"		"	"		
548	22759	Lophopsetta maculata, (Mitch.) Gill		Wood's Holl, Mass	"	"		"	"		
549	24611	Hippoglossoides platessoides, (Fabr.) Gill.		Halifax, N. S.	"	"		"	"		
550	24619	Hippoglossoides platessoides, (Fabr.) Gill.		"	"	"		"	"		
551	22690	Pollachius carbonarius, (Linn.) Bon		Gloucester, Mass.	"	"		"	"		
552	20595	Microgadus tomcodus, (Walb.) Gill.		Wood's Holl, Mass	"	"		"	"		
553	22631	Phycis tenuis, (Mitch.) Dekay.		Gloucester, Mass.	"	"		"	"		
554	23760	Zoarces anguillaris, (Peck.) Storer.		Provincetown, "	"	"		"	"		
555	18668	Dactylopterus volitans, (Linn.) Lac.		Wood's Holl, Mass	"	"		"	"		
556	18679	Dactylopterus volitans, (Linn.) Lac.		"	"	"		"	"		
557	22754	Prionotus evolans, (L.) Gill.		"	"	"		"	"		
558	23531	Prionotus carolinus, (L.) C. & V.		Crisfield, Maryla'd	"	"		"	"		
559	24336	Aspidophoroides monophlerygius (Bloch.) Storer.		Provincetown, M's	"	"		"	"		
560	22266	Bottus octodecemspinosus, Mitch.		Gloucester, Mass.	"	"		"	"		
561	13525	Coltus æneus, Mitch.		Wood's Holl, Mass	"	"		"	"		
562	24340	Centridermichthys uncinatus, (Rhdt.) Gunth.		E. Coast, U. S.	"	"		"	"		
563	22839	Hemitripterus americanus, (Gm.) Storer.		Gloucester, Mass.	"	"		"	"		
564	22651	Sebastes marinus, Linn.		"	"	"		"	"		
565	13630	Tangota onitis, (Linn.) Gunth.			"	"		"	"		
566	17629	Tantogolabrus adspersus,(Walb)Gill		Noank, Mass.	"	"		"	"		

567	20340	Holconotus rhodoterus, Ag..........	....	California..........	Alc'hol	U. S. Fish. Com.	....	Sept., 1880	U. S. Nat. Museum	....	....
568	16224	Scomber scombrus, Linn..........	....	Wood's Holl.......	"	"	....	"	"	....	....
569	18964	Decapterus punctatus, (Ag.) Gill ...	....	"	"	"	....	"	"	....	....
570	22784	Trachurops crumenophthalmus, (Bloch.) Gill..........................	....	"	"	"	....	"	"	....	....
571	24922	Carangus hippos, (L.) Gill..........	....	"	"	"	....	"	"	....	....
572	22768	Trachynotus carolinus, (L.) Gill.....	....	"	"	"	....	"	"	....	....
573	10402	Seriola zonata, (Mitch.) C. & V......	....	"	"	"	....	"	"	....	....
574	15082	Pronotus tricanthus, (Pech.) Gill....	....	Tompkinsville, N.	"	"	....	"	"	....	....
575	22757	Menticirrus nebulosus, (Mitch.) Gill	....	E. Coast U. S...[Y.	"	"	....	"	"	....	....
576	22758	Stenotomus argyrops, (L.) Gill......	....	Wood's Holl, Mass	"	"	....	"	"	....	....
577	23507	Pristipoma fulvomaculatum,(Mitch) Gunth..............................	....	Norfolk, Va.......	"	"	....	"	"	....	....
578	24812	Micropterus pallidus, (Raf.) Gill & Jordan............................	....	North Carolina....	"	"	....	"	"	....	....
579	7673	Ambloplites rupestris, (Raf.) Gill...	....	Yellow Creek, O..	"	"	....	"	"	....	....
580	6246	Lepomis auritus, (L.) Gill............	....	Sing Sing, N. Y...	"	"	....	"	"	....	....
581	9266	Xenotis peltastes, (Cope.) Jordan...	....	Michigan..........	"	"	....	"	"	....	....
582	24877	Eupomotis aureus,(Walb.) Gill & Jor	....	Wash. M'kt, from	"	"	....	"	"	....	....
583	24766	Centrarchus irideus, (Bosc.) C. & V.	....	" [N. C.	"	"	....	"	"	....	....
584	24767	Promoxys nigromaculatus, (Le S.) Girard	....	Wash. Market....	"	"	....	"	"	....	....
585	22800	Centropristis atrarius, (L.) Barn.....	....	Wood's Holl, Mass	"	"	....	"	"	....	....
586	7441	Perca fluvialitis.....	....	Ohio..............	"	"	....	"	"	....	....
587	24925	Morone americana, (Gmel.) Gill....	....	Wood's Holl, Mass	"	"	....	"	"	....	....
588	24846	Roccus lineatus, (Bl. Schu.) Gill....	....	Wash. Market....	"	"	....	"	"	....	....
589	22762	Pomatomus saltatrix, (Linn.) Gill...	....	Wood's Holl, Mass	"	"	....	"	"	....	....
590	13095	Amodytes americanus, De Kay.....	....	"	"	"	....	"	"	....	....
591	22858	Chirostoma menidium, (L.) Gill.....	....	Orland, Maine....	"	"	....	"	"	....	....
592	21451	Belone longirostris..................	....	Wood's Holl, Mess	"	"	....	"	"	....	....
593	24896	Esox reticulatus, Le S...............	....	Wash. Market	"	"	....	"	"	....	....
594	24581	Cyprinodon variegatus, Lac.........	....	Wood's Holl, Mass	"	"	....	"	"	....	....
595	13901	Fundulus pisculentus, (Mitch.) Val .	....	Casco Bay, Me....	"	....	....	"	"	....	....
596	24883	Fundulus parvipinnis................	....	San Diego, Cal....	"	....	....	"	"	....	....
597	8746	Percopsis guttatus, Ag..............	....	Lake Superior	"	....	....	"	"	....	....
598	13936	Osmerus mordax, (Mitch.) Gill......	....	Noank, Conn......	"	....	....	"	"	....	....
599	23184	Osmerus pacificus	....	Naas River, Ore...	"	....	....	"	"	....	....
600	22405	Salmo irideus, Gibbons..............	....	California..........	"	....	....	"	"	....	....
601	24434	Brevoortia tyrannus, (Latrobe) G'de	....	Yorktown, Va.....	"	....	....	"	"	....	....
602	20472	Alosa sapidissima, (Wils.) Linsly....	....	S. Hadley F'ls, M's	"	....	....	"	"	....	....
603	21687	Clupea harengus, Linn..............	....	Ipswich Bay, Mass	"	....	....	"	"	....	....
904	24975	Dorosoma crepidiarum, (Lac.) Gill.	....	Wash. Market	"	....	....	"	"	....	....
605	24897	Erimyzon sucetta, (Lac.) Jor.........	....	Potomac Rivar....	"	....	....	"	"	....	....
606	6853	Calostomus commersonii, (Lac.) Jor	....	Port Huron, Mich.	"	....	....	"	"	....	....
607	24893	Amiurus albidus, (Le S.) Gill........	....	Wash. Market....	"	....	....	"	"	....	....
608	23189	Amiurus catus, (L.) Gill.............	....	Potomac River....	"	....	....	"	"	....	....
609	24852	Amiurus catus, (L.) Gill.............	....	Wash. Market....	"	....	....	"	"	....	....
610	18012	Naturus insignis, (Rich.) Gill. & Jor.	....	Bainbridge, Penn.	"	....	....	"	"	....	....

Zoological Accessions to the Museum——Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Obtained by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
611	13589	Anguilla rostrata, (Le S.) De Kay	....	Wood's Holl, Mass	Alc'hol	....	....	Sept., 1880	U. S. Nat. Museum	....	....
612	22600	Squalus acanthias, L.	....	Gloucester, Mass.	"	....	....	"	"	....	....
613	....	Larva of sphinx moth	....	Minneapolis	"	....	....	....	....	1	....
614	....	Lupa, sp. ?	....	Virginia	"	Gov. Austin	1876	1876	Gov. Austin	2	....
615	....	....	....	Minneapolis	"	....	....	....	....	1	Crayfish
616	....	Lachnostirna quercina, Koch	....	Alabama	"	P. H. Mell, Jr.	1888	1880	P. H. Mell, Jr.	1	....
617	....	Torrubra elongata, Riley	....	Alabama	"	"	1880	1880	"	....	.... [presented
618	....	....	....	Mankato	"	D. Richards	1880	1880	D. Richards	1	Trap'dr spider
619	....	....	....	Grand Marais	"	H. Mayhew	1879	1879	H. Mayhew	1	Wat. beetle, pr
620	....	Carambyx	....	....	"	....	....	....	....	1	Presented
621	....	Corydalis	....	Minneapolis	"	H. Nachtrieb	1880	1880	H. Nachtrieb	1	"
622	....	Corydalis larva	....	"	"	"	1880	1880	"	1	"
623	....	....	....	....	"	Fred Reynolds	1880	1880	Fred. Reynolds	2	Im. locust, pre
624	....	Julus, sp. ?	....	Black Hills, Da.	"	N. H. Winchell	1874	1874	Geol. & N. H. Sur.	....	Presented
625	....	Caddisfly larva	....	Grand Marais	"	C. W. Hall	1879	1879	"	....	"
626	....	....	....	"	"	"	Aug., 1879	1879	"	....	Leeches, medi-
628	....	Parasite of lake trout	....	Grand Marais	"	"	1879	1879	"	....	.... [cal.
529	....	Gelasimus vocans	....	Virginia	"	Gov. Austin	1876	1876	Gov. Austin	1	Presented
630	....	....	F.	Minneapolis	"	H. V. Winchell	1880	1880	H. V. Winchell	1	Crayfish with
631	....	....	....	Minnehaha Creek	"	H. Nachtrieb	1879	1879	H. Nachtrieb	1	Crayfish [eggs
632	....	Echinus, sp. ?	....	Virginia	"	Gov. Austin	1876	1876	Gov. Austin	1	Presented
633	-....	Ophiura, sp. ?	....	"	"	"	1876	1876	"	1	"
634	....	Asterias, sp. ?	....	"	"	"	1876	1876	"	1	"
635	....	Lupa, sp. ?	....	"	"	"	1876	1876	"	1	"
636	....	Nepa apiculata ?, etc.,	....	Black Hills, Da.	"	N. H. Winchell	1874	1874	Geol. & N. H. Sur.	1	Custer Exp.
637	....	....	....	Minneapolis	"	H. Nachtrieb	1879	1879	H. Nachtrieb	1	Crayfish
638	....	....	....	....	"	....	....	....	....	2	"
639	1	Nymphon hirtum, Fabr.	....	Off Halifax, N. S.	"	U. S. Fish Com.	1877	May, 1880	U. S. Fish. Com.	1	....
640	2 a	Limulus polyphemus, Latr	....	Cape Cd Bay, shore	Dry	"	1879	"	"	1	....
641	2 c	Gelasimus pugnax, Smith	....	New Haven, Conn	In Alch	"	....	"	"	1	....
642	3 a	Callinectes hastatus, Ordway	....	" [shore.	"	"	....	"	"	1	....
643	3 b	Platyonichus ocellatus, Latr	....	Cape C'd B. surface	"	"	....	"	"	6	Young
644	4	Platyonichus ocellatus, Latr	....	Vineyard S'd, M'ss	Dry	"	....	"	"	1	....

645	5	Cancer irroratus, Say		Vineyard S'd, M'ss	In Alch	U. S. Fish Com.		May, 1880	U. S. Fish Com.	1	
646	5 a	Cancer irroratus, Say		Glouc. Mass. shore	"	"		"	"	4	Young
647	6	Hyas coarctatus, Leach		Gulf of Maine, 22 to 30 fath	"	"		"	"	1	
648	7	Libinia emarginata, Leach		Vineyard S'd, M'ss	"	"		"	"	1	
649	9	Eupagurus pollicaris, Stimp		Off Nautucket I	"	"		"	"	2	
650	9 a	Eupagurus pollicaris, Stimp		Off Noauk, Conn	"	"		"	"	1	
651	10	Eupagurus pubescens, Brandt		Coast of Maine, 22 to 34 fath	"	"		"	"	1	
652	11	Eupagurus bernhardus, Brandt		Gloucester, Mass	"	"		"	"	1	
653	11 a	Homarus americanus, Edw		New Haven, Conn	"	"		"	"	2	
654	12	Crangon vulgaris, Fab		Mass. Coast	"	"		"	"	4	
655	13	Pandalus borealis, Kroyer		Mass. B., 41 to 50 fa	"	"		"	"	Ind	
656	14	Pandalus montagui, Leach		" 42 to 50 fa	"	"		"	"	"	
657	15	Hyppolyte spina, Leach		Bay of Fundy, 10 to 20 fath	"	"		"	"	"	
658	15 a	Thysanopoda inermis, Kroyer		Cape Cod	"	"		"	"	"	From whale's [stomach
659	16	Thysanopoda norvegica, M. Sars		B. of Fundy, surf'c	"	"		"	"	3	
660	17	Mysis mixta, Lillyeborg		Mass. B., 40 to 50 fa	"	"		"	"	2	
661	18	Diastylis quadrispinosus, G. O. Sars		Off Grand Menan I., 8 to 10 fath	"	"		"	"	2	
662	19	Ptilocheirus pinguis, Stimp		Lang I. Sound, off Noank, Conn	"	"		"	"	5	
663	19 a	Talorchestia longicornis, Smith		Cape Cod, shore	"	"	1879	"	"	1	
664	20	Gammarus locusta, Fab		Gloucester H'rb, Ct	"	"		"	"	2	
665	21	Idotea robusta, Kroyer		Vineyard S'd, M'ss	"	"		"	"	2	
666	22	Idotea irrorata, Edw		"	"	"		"	"	3	
667	22 a	Æga psora, Kroyer		George's Banks	"	"		"	"	1	(On codfish)
668	23	Lepas facicularis, Ellis & Sol		Vineyard S'd, M'ss	"	"		"	"	Ind	
669	23 a	Balanus balanoides, Stimp		New Haven, Conn shore	"	"		"	"	"	
670	24	Lepidonotus squamatus, Deach		Bay of Funday, 10 to 25 fath	"	"		"	"	4	
671	25	Harmothoe imbricata, Mal..g		Bay of Funday, 10 to 25 fath	"	"		"	"	2	
672	27	Nephthys incisa, Malmgren		Off Vineyard S'd, 10 to 20 fath	"	"		"	"	3	
673	28	Nereis pelagica, Linn		Vineyard Sound, 6 to 12 fath	"	"		"	"	4	
674	29	Nereis virens, Malmgren		Gloucester, Mass. shore	"	"		"	"	Ind	
675	30	Nothria conchylega, Malmgren		Gulf of Me., 85 fath	"	"		"	"	3	
676	31	Nothria opalina, Verril		Gulf of Me., 97 to 175 fath	"	"		"	"	1	
677	32	Arebella opalina, Verril		Vineyard Sound, 8 to 12 fath	"	"		"	"	2	
678	34	Sternaspis fossor, Stimp		Mass. B, 25 to 45 fa.	"	"		"	"	7	
679	35	Clymnella torquata, Verril		Glouc., Mas., shore	"	"		"	"	4	

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number	NAME.	Sex	Locality.	Nature of Specimens.	Collected by	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
680	36	Thelepus cincinnatus, Malmgren		Bay of Fundy, 10 to 30 fath	Alc'hol	U. S. Fish Com.		May, 1880	U. S. F. C.	3	
681	37 a	Spirorbis lucidus, Mörch		Halifax, N. S.	"	"		"	"	Ind	
682	38	Spirorbis borealis, Dund		Glouc., Mss., shore	"	"		"	"	"	
683	39	Clitellio irrorata, Verril		"	"	"		"	"	"	
684	41	Sagitta elegans, Verril		Viney'dS's,surface	"	"		"	"	"	
685	43	Cerebrantulus ingeus, Verril		Glouc., M'ss, shore	"	"		"	"	2	
686	44	Cerebrantulus roseus, Verril		"	"	"		"	"	3	
687	45	Pentacta frondosa, Jaeg		Bay of Fundy, 10 to 40 fath	"	"		"	"	2	
688	45 a	Lophothuria fabricii, Verril		Grand Menan, N. B	"	"		"	"	1	
689	46	Thyone briareus, Selenlea		Vineyard S'd, M'ss	"	"		"	"	2	
690	47	Echinara chincusparma, Gray		"	Dry	"		"	"	4	
691	49	Strongylocentrotus dröbachiensis, A. Ag		Wood's Holl, Mass	Alc'hol	"		"	"	1	
692	49 a	Strongylocentrotus dröbachiensis, A. Ag		Off Cape Cod, 20 to 40 fath	"	"	1879	"	"	2	
693	50 a	Arbacia punctulata, Gray		Wood's Holl, Mass	Dry	"		"	"	1	
694	51	Asterias vulgaris, Stimp		Halifax, N. S.	Alc'hol	"		"	"	1	
695	52	Asterias forbesii, Verril		Vineyard S'd, M'ss	"	"		"	"	1	
696	53	Asterias forbesii, Verril		"	Dry	"		"	"	2	
697	53 a	Asterias frobesii, Verril		"	Alc'hol	"		"	"	10	
698	54	Leplasterias compta, Verril		Off Watch Hill, R. I., 22 fatn	"	"		"	"	1	
699	55	Cribrella sanguinolenta, Lutken		Mass. Bay, Gulf of Maine	"	"		"	"	2	
700	56	Ctenodiscus crispatus, D. & Kor		Mass. B, 40 to 50 fa	"	"		"	"	9	
701	56 a	Ctenodiscus crispatus, D. & Kor		" "	Dry	"		"	"	6	
702	57	Ophiopholis aculeata, Gray		Bay of Fundy, 10 to 100 4ath	Alc'hol	"		"	"	1	
703	58	Ophiopholis aculeata, Gray		Mess. Bay and Gulf of Maine	"	"		"	"	Ind	

704	59	Ophioglypha sarsii, Lyman	....	Mass. Bay, 20 to 125 fath.	Alc'hol	U. S. Fish Com..	....	May, 1880..	U. S. F. C......	5	....
705	59 a	Ophioglypha sarsii, Lyman	....	Mass. Bay, 20 to 125 fath.	Dry...	"	....	" ..	"	3	....
706	60	Ophioglypha robusta, Lyman	....	Bay of Fundy.....	Alc'hol	"	....	" ..	"	2	....
707	60 c	Astrophyton agassizii Stemp	....	Off Cape Cod, 25 to 35 fath.	"	"	1870	" ..	"	....	....
708	61 a	Urticina nodosa, Verril	....	Off Nova Scotia...	"	"	....	" ..	"	1	....
709	64	Alcyonium carneum, Ag	....	Casco B., 20 to 60 fa	"	"	....	" ..	"	1	....
710	65	Obelia geniculata, Hincks	....	Vineyard S'd, M'ss	"	"	....	" ..	"	Ind	....
711	66	Obelia dichotoma, Hincks	....	Casco Bay, Maine.	"	"	....	" ..	"	"	....
712	68	Sertularia cupressina, Linn	....	Nantucket Shoals	"	"	....	" ..	"	"	....
713	70	Sertularia pumila, Linn	....	Gloucester, Mass., low water.......	"	"	....	" ..	"	"	....
714	71	Hydrallmania falcata, Hincks	....	B. of Fdy, 10 to 60 fa	"	"	....	" ..	"	"	....
715	72	Sertularella tricuspidata, Hincks	....	" 50 to 55 fa	"	"	....	" ..	"	"	....
716	73	Diphasia fallax, Aggasiz	....	" 20 to 55 fa	"	"	....	" ..	"	"	....
717	73 a	Diphasia fallax, Aggasiz	....	Vineyard S'd, M'ss	"	"	....	" ..	"	"	....
718	76	Loligo pealii [illegible] Sueur	....	"	"	"	....	" ..	"	2	....
719	79	Buccinum undatum, Linn	....	Bay of Fundy.....	Dry...	"	....	" ..	"	1	....
720	80	Tritia trivittata, H. & A. Ad	....	Vineyard S'd, M'ss	" ...	"	....	" ..	"	....	....
721	81	Ilyanassa obsoleta, Stimp	....	"	" ...	"	....	" ..	"	....	....
722	81 a	Ilyanassa obsoleta, Stimp	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	10	....
723	82	Urosalpinx cinerea, Stimp	....	Vineyard S'd, M'ss	Dry....	" ...	....	" ..	"	....	....
724	83	Purpura lapillus, Lamarck	....	Gloucester, Mass.	Alc'hol	"	....	" ..	"	6	....
725	83 a	Purpura lapillus, Lamarck	....	Casco Bay, Me....	Dry....	"	....	" ..	"	4	....
726	84	Anachis avara, Perkins	....	Vineyard S'd, Mass	" ...	"	....	" ..	"	4	....
727	85	Astyris lunata, Dall	....	"	" ...	"	....	" ..	"	....	....
728	86	Lunatia heros, H. & A. Ad	....	"	" ...	"	....	" ..	"	1	....
729	87	Lunatia heros, H. & A. Ad	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	2	....
730	88	Littorina littorea, Menke	....	"	"	"	....	" ..	"	4	....
731	88 a	Littorina palliata, Gould	....	Casco Bay, Me....	Dry....	"	....	" ..	"	3	....
732	89	Littorina palliata, Gould	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	10	....
733	89 a	Littorina rudis, Gould	....	Casco Bay, Me....	"	"	....	" ..	"	Ind	....
734	90	Lacuna vincta, Turton	....	Gloucester, Mass..	"	"	....	" ..	"	8	....
735	91	Bittium nigrum, Stimpson	....	Vineyard S'd, Mass	Dry....	"	....	" ..	"	....	....
736	92	Crepidula fornicata Lam	....	"	" ...	"	....	" ..	"	....	....
737	95	Margarita helicina, Möll	....	Grand Menan.....	" ...	"	....	" ..	"	4	....
738	96	Acmaea [illegible]es[illegible]linalis, [illegible]n	....	Casco Bay, Me....	Alc'hol	"	....	" ..	"	6	....
739	96 a	Trachy[illegible]rmon ruber, [illegible]arp	....	Eastport, Maine..	"	"	....	" ..	"	2	....
740	97	Melampus lineatus, Say	....	Barnstable, Mass.	Dry....	"	....	" ..	"	....	....
741	98	Entalis striolata, Stimpson	....	Eastport, Me......	" ...	"	....	" ..	"	2	....
742	99	Clidophora trilineata, Carp	....	Vineyard S'd, M'ss	" ...	"	....	" ..	"	....	....
743	100	Spisula solidissima, Gray	....	"	" ...	"	....	" ..	"	3	....
744	100 a	Spisula solidissima, Gray	....	"	" ...	"	....	" ..	"	2	Young.........
745	102	Macoma subulosa, Mörch	....	Mass Bay and Gulf of Me..........	" ...	"	....	" ..	"	2	....
746	103	Venus mercenaria, Linn	....	New Haven, Ct...	" ...	"	....	" ..	"	2	....

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
747	104	Cyprina islandica, Lam	....	Mass Bay and Gulf of Maine	Dry	U. S. Fish Com.	....	May, 1880	U. S. F. C.	2	....
748	105	Astarte undata, Gould	....	Eastport, Maine	“	“	....	“	“	2	....
749	106	Toldia limatula, Woods	....	Vineyard S'd, M'ss	“	“	....	“	“	....	....
750	107	Toldia thraciformis, Stimp	....	Mass Bay and Gulf of Maine	“	“	....	“	“	2	....
751	108	Scapharca transversa, Ad	....	Vineyard S'd, M'ss	“	“	....	“	“	4	....
952	108 a	Modiola plicatula, Lamk	....	New Haven, Ct., Shore	Alc'hol	“	....	“	“	4	....
753	109	Modiola modiolus, Turton	....	Vineyard S'd, M'ss	Dry	“	....	“	“	1	....
754	109 b	Mytilus edulis, Linn	....	New Haven, Ct., shore	Alc'hol	“	....	“	“	4	....
755	110	Pecten irradius, Lamk	....	Vineyard S'd, M'ss	Dry	“	....	“	“	4	....
756	111	Pecten tenuicostatus, Migh	....	Off Watch Hill, R. I., 22 fath	“	“	....	“	“	1	....
757	112	Anomia aculeata, Gmelin	....	Casco Bay, Me	“	“	....	“	“	....	....
758	112 a	Ostrea virginiana, Lister	....	New Haven, Ct	“	“	....	“	“	1	....
759	113	Venericardia borealis, Carp	....	Off Noank, Conn	“	“	....	“	“	4	....
760	114	Nucula proxima, Say	....	Buzzard's B. and Vineyard S'd	“	“	....	“	“	....	....
761	115	Mya arenaria, Linn	....	Gilford, Conn	Alc'hol	“	....	“	“	1	....
762	120	Ascidia mollis, Verril	....	Gulf of Maine, 50 to 175 fath	“	“	....	“	“	1	....
763	121	Ascidiopsis complanata, Verril	....	B. of Fundy, shore to 50 fath	“	“	....	“	“	2	....
764	122	Molgula retoriformis, Verril	....	Bay of Fundy, 10 to 25 fath	“	“	....	“	“	2	....
765	123 b	Molgula manhattensis, Verril	....	Cape Cod, shore	“	“	1879	“	“	Ind	....
766	124	Glandula arenicola, Verril	....	Vineyard S'd, 10 to 20 fath	“	“	....	“	“	Ind	....
767	125	Halocynthia partita, Verril	....	Vineyard S'd, 3 to 12 fath	“	“	....	“	“	Ind	....

768	126	Halocynthia echinata, Verril	....	Grand Manan, 1 to 40 fath.	Alc'hol	U. S. Fish Com.	....	May, 1880	U. S. Fish Com.	3	....
769	127	Halocynthia pyriformis, Verril	....	Bay of Fundy, 1 to 45 fath.	"	"	....	"	"	2	....
770	128	Boltenia bolteni, Linn	....	Eastport, Me., 1 to 20 fath.	"	"	....	"	"	Ind	....
771	129	Perophora veridis, Verril	....	Vineyard S'd, 1 to 12 fath.	"	"	....	"	"	Ind	....
772	130	Botryllus gouldii, Verril	....	Viney'd S'd, shore	"	"	....	"	"	1	....
773	131	Amoroecium pellucidum, Verril	....	"	"	"	....	"	"	4	....
774	132	Amoroecium stellatum, Verril	....	"	"	"	....	"	"	2	....
775	133	Amoroecium constellatum, Verril	....	Off Nantucket, Mss	"	"	....	"	"	2	....
776	134	Leptochinum albidum, Verril	....	Vineyard S'd, M'ss	"	"	....	"	"	1	....
777	135	Leptochinum albidum, var. luteolum, Verril	....	"	"	"	....	"	"	Ind	....
778	136	Salpa caboti, Desor	....	" shore	"	"	....	"	"	6	....
779	137	Terebratulina septemtrionalis, Gr.	....	Casco Bay, Me....	"	"	....	"	"	4	....
780	137 a	Terebratulina septemtrionalis, Gr.	....	Eastport, Me., 1 to 60 fath.	"	"	....	"	"	5	....
781	138	Crisia eburnea, Lamouroux	....	Gloucester, Mass.	"	"	....	"	"	Ind	....
782	142	Flustrella hispida, Gray	....	" shore	"	"	....	"	"	"	....
783	143 a	Gemellaria loricata, Bush	....	Off Cape Cod, 20 to 40 fath.	"	"	1879	"	"	"	....
784	146	Bugula murrayana, Bush	....	Nantucket shoals, 8 to 12 fath.	"	"	....	"	"	"	....
785	147	Bugula turrita, Verril	....	Vineyard S'd and off Nantucket...	"	....	....	"	"	"	....
786	148	Mucronella nitida, Verril	....	Vineyard S'd, M'ss	Dry....	"	....	"	"	"	....
787	149	Membranopora pilosa, Farre	....	Gloucester, Mass.	Alc'hol	"	....	"	"	"	....
788	149 a	Membranopora pilosa, Farre	....	"	"	"	....	"	"	"	....
789	151	Hippothoa hyalina, Smith	....	Vineyard S'd, M'ss	Dry....	"	....	"	"	....	....
790	154 a	Chalina oculata, Bowerbank	....	Casco Bay, Me....	"	"	....	"	"	2	....
791	155	Suberites compacta, Verril	....	Off Nantucket M's	"	"	....	"	"	2	....
792	156 a	Suberites compacta, Verril	...	Cape Cod B., 15 fa	Alc'hol	"	....	"	"	1	....
793	156aa	Suberites compacta, Verril	....	....	Dry....	"	....	"	"	2	....
794	157	Cliona sulphurea, Verril	....	Vineyard S'd, M'ss	"	"	....	"	"	1	....
795	.....	Skull of Gen. Custer's hound	M.	Minneapolis	Mt'd...	E. S. Williams	1880	1880	E. S. Williams	1	....
796	.....	Skull of lynx	....	Grand Marais	"	C. W. Hall	"	"	Mayhew Bros.	1	....
797	.....	Skull of lynx	....	"	"	"	"	"	"	1	....
798	.....	Skull of ———	....	"	"	"	"	"	"	2	....
799	.....	Skull of fisher (?)	....	"	"	"	"	"	"	1	....
800	.....	Skull of rat	....	"	"	"	"	"	"	1	....
801	.....	Skull of bear	....	"	"	"	"	"	"	1	..[by purchase
802	.....	....	M.	England	"	....	....	"	Wakelin	1	Gold. pheasant
803	.....	....	M.	"	"	....	....	"	"	1	Starling
804	.....	....	F.	"	"	....	....	"	"	1	Europ'an quail
805	.....	Pinecola canadensis	F.	"	"	....	....	"	"	1	Pure grosbeak
806	.....	....	....	"	"	....	....	"	"	1	Sky lark

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
807					Mt'd.		1880	1880	Wakelin	1	Honey eater
808		Florida cerulea	M.		"	E. Moulton	1880	1880	Wm. Howling	1	Purchased
809		Mareca americana	F.		"		1876	1880	"	1	"
810		Mereca americana	M.		"		1876	1880	"	1	"
811		Anas boschas	M.	Minneapolis	"		1877	1880	"	1	"
812		Anas boschas	F.	Sandy L. M'polis.	"	Wm. Howling	June, 1880	1880	"	1	"
813		Bucephala albeola	M.	"	"		1879	1880	"	1	"
814		Bucepnala albeola	F.	Minnehaha	"		June, 1880	1880	"	1	"
815		Erismatura rubula	F.	Mississippi R.	"		1877	1880	"	1	"
816		Erismatura rubula	M.	"	"		1877	1880	"	1	"
817		Lophodytes cucullatus	M.	Minneapolis.	"		May, 1880	1880	"	1	"
818		Lophodytes cucullatus	F.	"	"		June, 1879	1880	"	1	"
819		Dafila acuta	M.	Minnetonka	"		June, 1880	1880	"	1	"
820		Dafila acuta	F.	"	"			1880	"	1	"
821		Aix sponsa	M.	Minneapolis	"			1880	Wakelin	2	Eng. partridge
822				England	"		June, 1879	1880	C. L. Herrick		Purchased
823		Chrysomitris tristis, (L.) Bon	M.	Minneapolis	"	C. L. Herrick	187[illegible]	1880	"		"
824		Euspiza americana, (Gm.) Bon.	M.	"	"	"	1879	1880	"		"
825		Icterus baltimore	M.	"	"	"	1879	1880	"		"
826		Molothrus ater (Bodd.) Gray	M.	"	"	"	1879	1880	"		"
827		Dolichonyx oryzivorus, (L.) Sw.	M.	"	"	"	1878	1880	"		"
828		Sialia sialis, L.	M.	"	"	"	1879	1880	"		"
829		Contopus borealis, (Sw.) Bd.		"	"	"	1879	1880	"		"
830		Mimus carolinensis, L.	M.	"	"	"	1379	1880	"		"
831		Melospiza melodia, Bd.		"	"	"	1879	1880	"		"
832		Goniaphea ludoviciana, Bond.	M.	"	"	"	1879	1880	"		"
833		Goniaphea ludoviciana, Bond.	F.	"	"	"	1879	1880	"		"
834		Quiscalus purpureus,(Barber) Licht.	M.	"	"	"	1879	1880	"		"
835		Agelæus, ?		"	"	"	1876	1880	"		"
836		Turdus migratorius, L.		"	"	"	1879	1880	"		
837		Callinectus hastatus		Salem, Mass.	Alc'hol	C. W. Hall	Aug., 1880	1880	C. W. Hall	3	
838		Sarda pelamys		Manchester, Mass.	"	"	"	1880	"		
839		Tautogolabrus adspersus, Gill		"	"	"	"	1880	"	Sev	

840	.....	Asterias vulgaris	....	Salem, Mass.	Alc'hol	C. W. Hall	Aug. 1880	1880	C. W. Hall	Ind	
841	.....	Loligo pealli, Le S.	....	Manchester, Mass.	“	“	“	1880	“	12	
842	.....	Homarus americanus, Dekay	....	Salem, Mass.	“	“	“	1880	“	2	
843	.....	Bucephala islandica	F.	Minneapolis	M'td	C. L. Herrick	Jan. 1877	1877	C. L. Herrick	....	Presented
844	.....	Ampelis cedrorum, L.	M.	Owatonna	“	M. B. Dunnell	Mar. 28, '81	1881	M. B. Dunnell	....	“
845	.....	Ampelis cedrorum, L.	F.	Owatonna	“	“	“	1881	“	....	“
846	.....	Secomber secombrus, L.	....	Manchester, Mass.	Alc'hol	C. W. Hall	Aug. 1880	1880	C. W. Hall	3	
848	.....	Merlucius bilinearis, Gill	....	Salem, Mass.	“	“	“	1880	“	1	
848	.....	Clupea harengus, L.	....	Manchester, Mass.	“	“	“	1880	“	Sev	
849	.....	Pomolobus pseudoharengus, Gill	....	“	“	“	“	1880	“	4	
850	.....	Rana pipens, L.	....	Salem, Mass.	“	“	“	1880	“	6	
851	27284	Gasterosteus (aculeatus, var.) cataphractus, (Pallas) J. & G.	....	Puget Sound	“	U. S. Fish Com.		1881	U. S. Nat. Museum	1	
852	27115	Pleuronichthys decurrens, J. & G.	....	San Francisco, Cal	“	“		1881	“	1	Type
853	27273	Pleuronectes stellatus, Pallas.	....	Puget Sound	“	“		1881	“	1	
854	27121	Parophrys isolepis, (Lock.) J. & G.	....	“	“	“		1281	“	1	Type
855	27057	Parophrys vetulus, Grd.	....	Monterey, Cal.	“	“		1881	“	1	“
856	27325	Citarichthys sordidus, (Grd.) Gthr.	....	Puget Sound	“	“		1881	“	1	
857	27121	Hippoglossoides exilis, J. & G.	....	San Francisco, Cal	“	“		1881	“	1	Type
858	27263	Hidpoglossoides elassodon, J. & G.	....	Puget Sound	“	“		1881	“	1	“
859	24874	Paralichthys maculosus, Grd.	....	San Diego, Cal.	“	“		1881	“	1	“
860	27258	Lumpenus anguillaris, (Pallas) Gill.	....	Puget Sound	“	“		1881	“	1	
861	27327	Xiphister rupestris, Jor. & Gill	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	Type
862	27001	Xiphister rupestris, Jor. & Gill	....	Monterey, Cal.	“	“		1881	“	1	“
863	26999	Xiphister mucosus, (Grd.) Jor.	....	“	“	“		1881	“	1	
864	27328	Xiphister mucosus, (Grd.) Jo.r.	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	
865	26998	Cebedichthys violaceus, Grd.	....	Monterey Cal	“	“		1881	“	1	
866	27339	Anopharchus alectrolophus, (Pallas) J. & [illegible]	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	
867	26994	Apodichthys fucorum, Jor. Gill	....	Monterey, Cal.	“	“		1881	“	1	Type
868	27330	Muraenoides ornatus, (Grd.) Gill	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	
869	27277	Porichthys porosissimus, (Cuv. & Val.) Gthr.	....	Puget Sound	“	“		1881	“	1	
870	27329	Gobiesox reticulatus, Grd.	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	
871	27331	Ascelichthys rhodorus, J. & G.	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	Type
872	27133	Artedius quadriseriatus Lock.	....	San Francisco Cal	“	“		1881	“	1	
873	27261	Aspicottus bison, Grd.	....	Puget Sound	“	“		1881	“	1	
874	27267	Leptocottus armatus, Grd.	....	“	“	“		1881	“	1	
875	27333	Oligocottus maculosus, Grd.	....	Cape Flattery, Wash. Territory	“	“		1881	“	1	
876	27051	Oligocottus analis, Grd.	....	Monterey, Cal.	“	“		1881	“	1	
877	25076	Sebastichthys chrysomelas, J. & Gilb	....	Santa Barbara Cal	“	“		1881	“	1	Type
878	26908	Sebastichthys rastrelliger, J. & Gilb	....	Santa Barbara Cal	“	“		1881	“	1	“

Zoological Accessions to the Museum—Continued.

Catelogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED.		No. of Specimens.	Remarks.
								When.	Whence.		
879	27293	Sebastichthys auriculatus, (Grd.) Gill (var.)	....	Puget Sound	Alc'hol	U. S. Fish Com.	....	1881	U. S. Nat. Museum	1	....
880	26061	Sebastichthys rosaceus, (Grd.) Lich.	....	Monterey, Cal.	"	"	....	1881	"	1	....
881	27278	Hexagramus dicagramus, (Pallas) J & G	M.	Puget Sound	"	"	....	1881	"	1	....
882	27027	Zanolipis latipinnis, Grd	....	Point Reges, near San Francisco	"	"	....	1881	"	1	....
883	27282	Anoplopoma fimbria, (Pallas) Gill.	....	Puget Sound	"	"	....	1881	"	1	....
884	26794	Gillichthys mirabilis, Cooper	....	San Diego, Cal	"	"	....	1881	"	1	....
885	27376	Pseudojulis modestus,(Grd.) Gthr.	....	Santa Barbara Cal	"	"	....	1881	"	1	....
886	27078	Abeona minima, (Gibbons) Gill	....	Monterey, Cal.	"	"	....	1881	"	1	....
887	26996	Abeona aurora, Jor. & Gilb	....	"	"	"	....	1881	"	1	Type
888	27296	Cymatogaster aggregatus, Gibbons.	....	Puget Sound	"	"	....	1881	"	1	....
889	26990	Brachyistus frenatus, Gill	....	Monterey, Cal.	"	"	....	1881	"	1	....
890	27075	Holconotus analis, (A. Ga.) J. & G.	....	"	"	"	....	1881	"	1	....
891	25065	Holconotus argenteus, (Gibb.) J & G	....	Santa Barbara Cal	"	"	....	1881	"	1	....
892	25077	Amphistichus argenteus, Ag	....	"	"	"	....	1881	"	1	....
893	26885	Amphistichus argenteus, Ag	....	"	"	"	....	1881	"	1	....
894	27017	Hypsurus caryi, (L. Ag.) A. Ag	....	Monterey, Cal	"	"	....	1881	"	1	....
895	27079	Hypsurus caryi, (L. Ag.) A. Ag	....	"	"	"	....	1881	"	1	....
896	27014	Ditrema jacksoni, (Ag.) Gtr	....	"	"	"	....	1881	"	1	....
897	26987	Ditrema atripes, Jor. & Gilb	....	"	"	"	....	1881	"	1	Type
898	26988	Ditrema furcatum, (Grd,) Gtr	....	"	"	"	....	1881	"	1	....
899	27018	Damalichthys argyrosomus, (Gd.) J. & G.	....	"	"	"	....	1881	"	1	....
900	26972	Genyonemus lineatus, (Ayres) Gill.	....	"	"	"	....	1881	"	1	....
901	26873	Umbrina xanti, Gill	....	Santa Barbara Cal	"	"	....	1881	"	1	....
902	26753	Cynoscion parvipinnis, (Ayres).	....	San Diego, Cal	"	"	....	1881	"	1	....
903	26754	Serranus nebulifer, (Grd.) Steind	....	"	"	"	....	1881	"	1	....
904	26910	Stromaleus simillimus, (Ayres) Gill.	....	Santa Barbara Cal	"	"	....	1881	"	1	....
905	26838	Trachurus plumieri, (Lac.) J. & G.	....	San Pedro, Cal	"	"	....	1881	"	1	....
906	25035	Atherinops affinis, (Ayres) Steind	....	Santa Barbara	"	"	....	1881	"	1	....
907	26766	Leuresthes tennis, (Ayres) J. & G.	....	San Diego, Cal	"	"	....	1881	"	1	....

908	26907	Exocœtus californicus, Cooper......	....	Santa Barbara Cal	Alc'hol	U. S. Fish Com..	....	1881	U. S. Nat. Museum	1	....
909	27136	Osmerus thaleichthys, Ayres.......	....	San Francisco Cal	"	"	....	1881	"	1	....
910	27250	Salmo purpuratus, Pallas, (Salmo clarki, Rich..........................	....	Puget Sound......	"	"	....	1881	"	1	....
911	26786	Stolephorus delicatissimus, (Grd.) J. & G..................................	....	San Diego, Cal....	"	"	....	1881	"	1	....
912	26785	Stolephorus compressus,(Grd.)J & G	....	"	"	"	....	1881	"	1	....
913	24886	Clupea sagax, Jenyns..............	....	"	"	"	....	1881	"	1	....
914	27283	Mylochilus caurinus, (Rich.) Ag....	....	Columbia River...	"	"	....	1881	"	1	....
915	27226	Chimæra colliei, Bennett...........	....	San Francisco, Cal	"	"	....	1881	"	1	....
916	.....	Colosoma, sp. ?, etc................	....	Minnetonka	"	C. L. Herrick....	1877	1877	C. L. Herrick......	Ind	* ....
917	.....	Coccygus erythrophthalmus, Wils..	....	Minneapolis	"	"	June 17, '78	1878	"	1	† ....

*From the gizzard of swallow-tailed kite. †Nestling, half grown.

CATALOGUE OF ARCHÆOLOGICAL SPECIMENS IN THE GENERAL MUSEUM.

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1. Flint arrow point from near Bismarck. Presented by Col. C. A. Lounsbury.
2. Chert implement, unfinished; from near Bismarck. Presented by C. A. Lounsbury.
3. Quartz chippings (fine), Little Falls, Minn. Collected by N. H. Winchell.
4. Quartz chippings (coarser), Little Falls, Minn. Collected by N. H. Winchell.
5. Quartz chippings (coarse), Little Falls, Minn. Collected by N. H. Winchell.
6. Chert implement, "finished." Mouth of the Little Elk River, near Little Falls. Collected by N. H. Winchell.
7. Quartz implements, Little Falls, Minn. Collected by N. H. Winchell.
8. Copper spear-point. Medicine Lake, near Minneapolis. Presented by Henry W. Howling.
9. Stone hammers, from the ancient mines of Isle Royale. Collected by N. H. Winchell.
10. Charred wood, from the ancient mines of Isle Royale. Collected by N. H. Winchell.
11. Pounded copper flakes from the ancient mines of Isle Royale. Collected by N. H. Winchell.
12. Three human skulls from the mounds at Big Stone Lake. Collected by N. H. Winchell.
13. Blue-glass bead, from the mounds at Big Stone Lake. Collected by N. H. Winchell.
14. Perforated bone disk (bead?), taken from the mounds at Big Stone Lake by N. H. Winchell.
15. Red Catlinite pipe, from the upper Minnesota River, formerly ownedby Mireall and Roberts. Presented by N. H. Winchell.
16. Indian pipe, of the "pipestone" at Fort Francis. Collected by N. H. Winchell.
17. Burnt clay pipe, from the mounds opened near Lanesboro. Presented by B. A. Man, Esq.
18. Photograph of clay image of the human face, found in the Lanesboro mounds. Presented by G. K. Day, Esq.
19. Flint chips and shells, from the Atlantic coast near Salem, Mass. Collected by C. W. Hall.
20. Stone hammer, withed, from near the Lower Agency on the Minnesota River. Collected by N. H. Winchell.
21. Collection of arm and leg bones, including one perforated *humerus*, from the mounds at Big Stone Lake. Collected by N. H. Winchell.

22. Lot of human teeth taken from the mounds at Big Stone Lake. Collected by N. H. Winchell.
23. Miscellaneous bones and fragments of bones, mostly human, from the mounds at Big Stone Lake. Collected by N. H. Winchell.
24. Pottery fragments, from near Bismarck. Presented by Col. C. A. Lounsbury.
25. Arrow heads, from Spring Valley, presented by John Kleckler.
26. Chippewa bark canoe and two paddles made at Grand Portage, Lake Superior; used by the Geological survey. Collected by N. H. Winchell.
27. Human femur from a mound, Sec. 6, Rutland, Martin county. Collected by Warren Upham.
28. Portion of a skull and jaw from a mound, Sec. 6, Rutland, Martin county. Collected by Warren Upham.
29. Left ramus of jaw, from a mound, Sec. 6., Rutland, Martin county. Collected by Warren Upham.
30. Pottery, probably by recent Indians. E. side of Talcott Lake, 1—2 ft. below the surface. Land of Wm. Crapey, ne ¼ sec. 30, Southbrook, Cottonwood county. Collected by Warren Upham.
31. Human skull, from a mound, Green Lake, Kandiyohi county. Collected by C. M. Terry.
32. Fragments of two human skulls, Green Lake, Kandiyohi county. Found in a mound. Collected by C. M. Terry.
33. Fragments of leg bones, Green Lake, Kandiyohi county. Collected by C. M. Terry.
34. Water-worn pebble (supposed to be wrought by man), Green Lake, Kandiyohi county. Collected by C. M. Terry.
35. Teeth and bones of (buffalo?), Green Lake. Collected by C. M. Terry.
36. Arrow-head of flint, Rochester, Minn. Presented by W. D. Hurlbut.
37. Quartz arrow-head chippings, (unassorted), Pike Rapids. Collected by N. H. Winchell.
38. Quartz fragments and chippings (also two pieces of gneiss), dug from the alluvium at Little Falls. Collected by N. H. Winchell.
39. Flint arrow-head, Medicine Lake, Hennepin county?
40. Pottery, bones, piece of skull, etc. In black soil 1½–2½ feet below the surface, Green Lake, Kandiyohi county. Collected by Warren Upham.
41. Bones, pottery, chipped flints, Green Lake. Warren Upham.
42. Hatchet (recent) made of Catlinite.
43. Gunflints, (2 spns.) Found at Gunflint Lake in 1878, by N. H. Winchell.
44. Gunflints, Oxford Mills, Canon Falls, Goodhue county. Collected by N. H. Winchell.
45. Bones, pottery, etc., Green Lake. Warren Upham.
46. Human *ulna*, from mounds near St. Peter. Deposited in the museum by J. Blackiston.
47. Foot bone (great toe), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

48. Finger bone (had a ring on) from mounds near St. Peter. Deposited in the museum by J. Blackiston.

49. Fragment of *radius*, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

50. Silver wristlet, stamped "Montreal" and "B C," from mounds near St. Peter. Deposited in the musem by J. Blackiston.

51. Two copper ear pendants (tubular, one has hair in it), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

52. String of thirty, small, white china beads, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

53. One large, brown, glass bead, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

54. Four common pins, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

55. One sewing needle, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

56. Pearl ornament, somewhat heart-shaped, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

57. Quartz, arrow point (opaque white), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

V.

LIST OF BOOKS IN THE LIBRARY OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY.

Journal of the Academy of Natural Science of Philadelphia. 1817 to 1840. Eight volumes.

Proceedings of the Academy of Natural Sciences of Philadelphia. 1841 to 1878. Thirty volumes.

Journal of the Academy of Natural Sciences of Philadelphia. New series, 4to. 1847 to 1881. Eight volumes.

British Palæozoic Rocks, and Fossils. Sedgwick & McCoy. 4to. 1855.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology. 1846 to 1872. Four volumes.

Transactions of the Geological Society of Glasgow. Palæontological series. Part I.

The Silurian Brachiopoda of the Pentland Hills. Thomas Davidson.

Owen's Odontography. Text and Atlas. Two volumes. 1840–1845.

The Geological Survey of New York. Annual Reports for the years 1837, 1838 and 1840. Two volumes.

Transactions of the Geological Society of Glasgow. Vol. 1, Part II. On the phenomena of the glacial drift of Scotland. By Archibald Geikie.

Transactions of tho Academy of Science, St. Louis. Vol. IV, No. 1, 1880.

Owen's Geological Survey of Wisconsin, Iowa and Minnesota. One volume 4to.

The Canadian Naturalist and Geologist. Vols. I to VIII. 1853 to 1863. Montreal.

The Canadian Naturalist and Journal of Science. Vols. I to VIII. 1864 to 1875. Montreal. [Vol. 4 has only Nos. 1, 2 and 4. Vol. 6 has only Nos. 1, 2 and 3.

Traite de Palæontologie. Pictet. 2d Edition. Paris 1853. Four volumes, 8vo and 4to Atlas.

Publications of the Palæontographical Society. London. Thirty volumes, 4to. From 1848 to 1876. (31 vols. as issued.)

Murchison's Silurian System, 4to; and case with large map.

Russia and the Ural Mountains, 4to. Vol. 1, Geology. Vol. II, Palæontologie

VI.

THE WATER SUPPLY OF THE RED RIVER VALLEY.

Since the examination of this important subject in 1877, and the discussion in the report of that year, very general attention has been given to the ways and means of obviating the difficulties. In a great many instances the same methods of curbing wells with pine planks, attended by the same serious consequences, have been followed, but the more enlightened well-diggers, and the proprietors of large farms have generally abandoned that manner of curbing wells, and have resorted to tiling or brick, or to iron tubing; and in numerous cases deep wells have penetrated the drift to that depth where a supply of non-alkaline water has been reached, having an artesian overflow,

At South Crookston, Mr. E. S. Corser bored to the depth of 190 feet, penetrating through the blue clay into coarse sand, or fine gravel, affording sweet, cool water, quite soft, which rises ten feet above the surface, through a three inch pipe at the rate of three pailfuls per minute.

At Lockhart, Polk county, Mr. O. E. Spear has sunk four wells which supply artesian water. That on the Lockhart farm is 140 feet deep; it has a great pressure upward, the water rising, when unconfined, in a four-inch tube to the height of five feet above the surface of the ground.

The artesian "salt well" at St. Vincent was sunk by the St. Paul and Pacific railroad company, the work being done by Mr. O. E. Spear, of Minneapolis. Respecting the strata passed through, and the position of the well, the following communication from Capt. Edward Collins, of Fort Pembina, gives full particulars. A sample of the water of this well is being analyzed by the survey, and will be reported in a general report on the *Hydrology of the State.*

FORT PEMBINA, D. T., January 20, 1881.

N. H. Winchell, State Geologist, Minneapolis, Minn.

SIR: In response to your communication of the 8th inst., I have the honor to enclose herewith a trace of a drawing, showing the section passed through in boring the artesian well at St. Vincent, Minn.

The well has been stopped to prevent the flow of salt water, and a specimen cannot be sent as desired. Some idea of its character may be inferred from the fact that a dish holding one inch in depth, measuring five inches across the top and three inches across the bottom left upon evaporation about 1/8 of an inch in thickness of a deposit, perfectly clear and reported by the assistant surgeon at the Post (Dr. H. O. Perley, U. S. A.) as chiefly made up of common salt with a mixture of lime and magnesia. The altitude to which it would rise was not ascertained. It flowed over the pipe at about the rate of a common water bucket in something less than a minute as nearly as can be recollected. The water was clear; temperature judged not far from 50° and effervesced slightly upon coming to the air.

The stratum of limestone concrete was easily drilled and the pipe was forced after it with great difficulty, injuring it at the bottom in so doing. A smaller pipe should have been inserted and carried through this deposit. The stratum of gravel underneath was very loose and dry, the pebbles identical with those found in connection with the Cretaceous deposits on the Missouri river.

The sand in which the water was found appeared the same as that on each side of the valley where it meets the table land.

The nearest salt water is in a small tributary of the Red River from the west a few miles south of this point. This stream coming into the valley fairly fresh, though somewhat alkaline, emerges from a small lagoon, very salt, having had apparently, at this point, some communication with the salt deposit, which appears to underlie the valley.

No trace of any organic body could be seen in any of the strata penetrated. They are considered as of the Cretaceous period.

Water is found by the settlers generally by digging a few feet in the marly subsoil. It is nothing but surface water, though it can be, and is used for all domestic purposes. The best water in the valley is from the Red River itself, and this is really good water, nor is there likelihood of finding any other source of supply except by boring very deep artesian wells or storing rain water in cisterns.

It is hoped the experiment of sinking a well far enough to strike a supply of pure water will be undertaken.

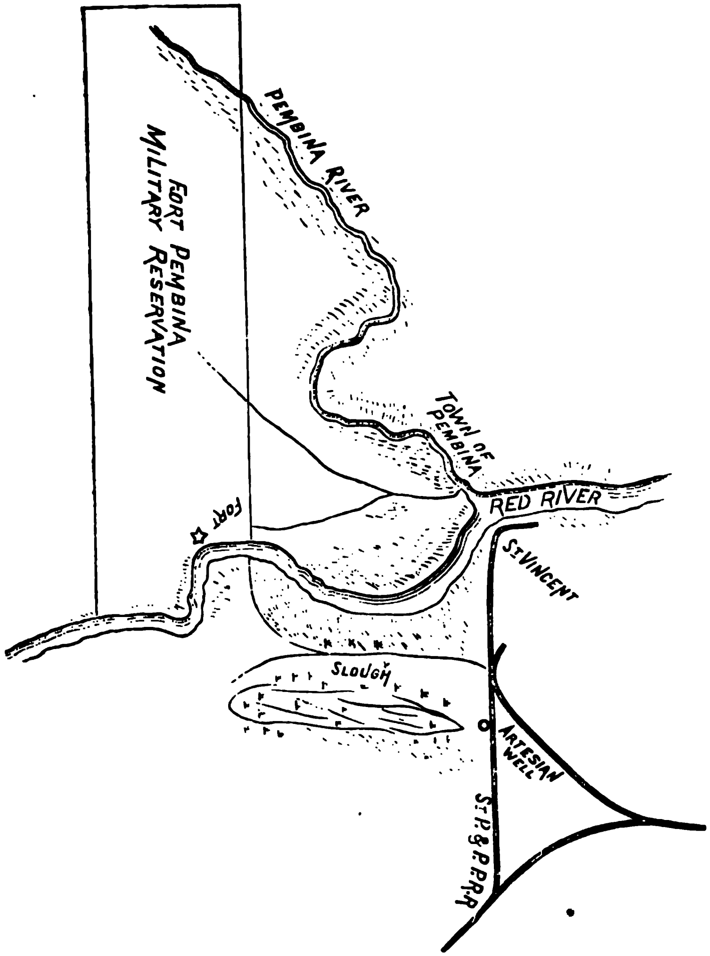
Please acknowledge receipt.

Very respectfully,
Your obedient servant,
EDWIN COLLINS,
Captain 17th Infantry,
Commanding Post.

Section showing deposits in the Red River Valley, near Fort Pembina, D. T. as found in boring for water at St. Vincent by St. P. & Pacific R. R. Co., Jan. and Feb., 1879.

Scale—one inch to 30 feet.

Road Bed of St. P. & P. R. R.	0
Filling.	5
Alluvium.	3
Pale, drab-colored, clayey marl, very compact and uniform throughout its whole thickness until near surface of underlying rock when a few lime pebbles were noticed. No water in any part.	112
Limestone concrete, containing water-worn pebbles—soft, easily drilled.	15
Made up of hard and soft pebbles and sand, some flint interspersed.	10
Clay, compact, blue.	4
Sand, very loose; mixed with pebbles; containing water flowing to top of pipe, very salt and unfit for use.	16
	165



This water seems not, according to Dr. H. O. Perley, U. S. A. at Fort Pembina, to be a pure brine of chloride of sodium, but contains, along with sodium, a considerable quantity of magnesium and calcium. In other words it is one of the alkaline waters of the valley.

At Audubon station two wells have a depth of sixty feet. One is the town well and the other is that of Wm. H. Irish. In these the water rose nearly to the top, but does not overflow.

On sec. 28, Hamden Becker county, the well of John Croll, 75 ft. deep, supplies water that rises 14 ft. above the surface. Another three miles further north, owned by E. N. Jellum. has a depth of 100–110 feet, and is also a flowing well

At Glyndon, on the farm of G. S. Barnes, is a well 112 feet deep, in which the water rose 102 feet.

In Wilkin county, Campbell village, the well at the Pacific House is 47 feet deep and the water stands at 6 ft. below the top; and another on sec. 10, T. 130, R. 46, owned by Robert Glover has a depth of 53 feet, and the water rose to within four feet of the top.

The railroad well at Tintah, in Traverse county, is 55 feet deep and is a flowing well, and another 4 miles S. E. of this was formerly flowing. The water of the Tintah well was chemically examined and reported in 1877.

It seems probable that this method of obtaining water will become common in the valley of the Red river of the North. The conformation of the drift deposits is such as to warrant the expectation that over a large area, on both sides of the river, artesian water can be obtained. It is similar to that in northwestern Ohio. The continuity of the till from the Leaf Hills across the valley westward, is like that of the drift sheet in the Maumee valley. The artesian wells at Toledo, and in Defiance county, are exactly duplicated by those at Glyndon and Crookston. The rolling and more gravelly drift of the Leaf Hills furnishes the supply and reservoir for these wells. When the water has once entered below the clay sheet it finds no exit through it upward, and remains under hydrostatic pressure, which forces it upward with great violence when it is released by sinking these wells. While several of these wells have given a non-alkaline water, that cannot be expected of all such wells in the valley.

Simple Tests of the Qualities of Water.

The detection and determination of the mineral and especeially organic of the impurities of water, when carried to ultimate results, is one of the difficult opperations of chemical manipulation; but a few directions can be given to enable any one to make some general distinctions, by means of such reagents as are accessible either at home or at the nearest drug store. These would be of use to those who desire to know something about the nature of the impurities found in the water of their wells, but do not wish to incur the expense of a full quantitative analysis.

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*These tests have been selected as the most easily available; with the co-operation and assistance of Prof. Dodge.

1. Solids in Solution.

Lime. This is mostly in solution as bicarbonate, or as sulphate, and is found in nearly all common wells; it is known by the familiar quality which is described as "hard," *i. e.*, with common soap it produces a *second soap* which is precipitated, or floats in flocks in the water. It also becomes evident, when the water is boiled, by the formation of a crust of lime on the interior of the kettle. A chemical test consists in adding a few drops of hydrochloric acid, then a few drops of oxalic acid (2 drms. in 2 oz. water, cost 10 cents.) and then aqua ammonia, when a white precipitate is formed.

Iron. If a well contain chalybeate water, which is also commonly the case in gravelly districts, it has an "irony" taste, and on repeated evaporation on a plate will leave a rusty sediment. The evaporation is best performed in a teacup placed in a tin cup of boiling water on a hot stove. The brown residue is mostly oxide of iron. To confirm this, add to the residue a drop or two of pure hydrochloric acid, than a drop of ferrocyanide of potassiun; a blue color and a precipitate is produced. (for solution of ferrocyanide of potassium, 2 drams, in 2 oz. distilled water; cost about 12 cents). Water may contain as much as two-tenths grain of iron per gallon, without being injurious as a drinking water.

A delicate test for iron in water consists in stirring a quantity of the water, in a porcelain dish, with a glass rod previously moistened with sulphide of ammonium If the water becomes colored or turbid, it contains either lead, copper or iron. If a few drops of hydrochloric acid then be added, and the color disappears or is sensibly reduced, the water contains iron; but if not, the coloration was produced either by lead or copper.

Lead and copper. The above test for iron will determine the presence or absence of these metals. If lead, copper aud iron are all present, the coloration will be reduced somewhat, but will not wholly disappear. [Sulphide of ammonium solution 2 drams, with bottle should cost about 20 cents. The bottle should have a dark paper pasted all around it.]

Alkalies and Alkaline Earths. In most of the surface and well-waters of the western part of the State, particularly in those parts where the "blue clay" exists, the product of the glacial epoch, is found a greater or less amount of either soda or potassa, as well as of the alkaline earths, lime and magnesia. These are derived from the clay, or glacial-drift deposit that covers that part of the State.

as well as much of Iowa, Nebraska and Dakota. To the drift they were supplied by the Cretaceous clays and shales which by their disintegration have so largely augmented the impervious drift-sheet in those States. They came originally from the waters of the alkaline ocean, which deposited the Cretaceous rocks These alkalies (soda and potassa) if present in observable or objectionable quantities, can be detected by the taste. They cause a soapy, or alkaline, or somewhat nauseating taste in the water. Persons who are addicted to the use of such water soon lose the ability to distinguish these alkalies, and they may experience little or no injurious effects; but a novice is at once struck with the peculiar taste, and perhaps suffers a derangement of the disgestive system if he persists in drinking the water. Such waters are not odorous. Water containing these impurities only is clear, and to the sight and smell is very inoffensive. It is when they come into contact with vegetation, or any organic substance, that they become the cause of rapid chemical reactions that result in foul odors. The organic acids replcae the acids in combination with the alkalies, and sulphuretted hydrogen, and perhaps other gases, are set free to permeate the water or to pass away in the air. The special chemical tests for proving the presence of soda or potassa are rather too complicated to be of service to the non-professional well-owner. If a more delicate examination is desired several gallons of the water must be sent to some practical chemist. If the water has a bitter taste, like epsom salt, it shows the presence of sulphate of magnesia.

2. Organic Impurities.

The presence of organic impurities in the wells of the prairie portion of the State is very common. These do not come from the clay in which the wells are dug, but from the pine curbing or some other local, and generally removable, cause in the surroundings of the well. Sometimes a long wooden tube, serving for a pump, is the source. The supply of these organic impurities is provoked and hastened by the prevailing alkaline qualities of the waters. (*See the sixth annual report for a full discussion of the water supply for domestic uses in the western part of the State*). These organic impurities are the chief source of danger to the farmer, as they have been the cause of hundreds of cases of typhoid fever. If the organic impurities are odorous and very offensive, or if the water contain sulphuretted hydrogen, the fact may be shown by throwing into a tumblerful a pinch of sugar of lead, when the water will become black.* If the organic impurities are not odorous, so as to attract attention, still their presence may be detected by what is known as the "ammonia process." This method is in general use among water analysts, though the "permanganate process" is also employed, the latter being the more simple, but the former the more delicate and correct. For the purpose of the well-owner it is best to state here only the permanganate process. A dilute solution of permanganate of potash is to be added to a tumbler nearly filled with the water to be tested. If the water is free from organic impurities, the coloration of the water by this addition, will be permanent; but the clarification of the water, in a moment, indicates the presence of organic poison. The greater the amount of the permanganate necessary to produce continued coloration the greater the impurity of the water.

Another test for organic matter, but which is not fully reliable, is to heat on a teaspoon some of the matter obtained by evaporation in a tea-cup; if it blackens and then whitens again, organic matter is shown.

3. Gaseous Substances.

Sulphuretted Hydrogen. As already stated for the detection of odorous organic impurities, as they generally occur in wells in the western part of Minnesota, in connection with alkaline mineral ingredients, this gas can be shown, not only by the smell, but also by the sugar-of-lead test. But there are some wells that are genuine sulphur wells, or sulphur springs, that derive free sulphuretted hydrogen from the rocks underlying, and contain no noxious organic matters. The test here may be the same. Further, such waters will cause a blackening of the metallic dippers and pails in which it is handled. Such waters are not noxious, but constitute some of the famed mineral waters of the country.

Carbonic acid. (Most commonly with lime). Add clear lime water. There will be a white precipitate which will dissolve on adding a little hydrochloric acid.

Carburetted Hydrogen. Besides the odors that arise from wells contaminated by organic decay, the principal gas from which is sulphuretted hydrogen, there are some wells in western Minnesota that have an odor somewhat different, resulting from the distillation of gas from the lignites of the Cretaceous, with which they come in contact. The gas can be distinguished from sulphuretted hydrogen by the fact that the addition of sugar of lead will not cause the water to become inky black.

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*To make this test more reliable, dissolve the sugar of lead first with a little carbonate of soda in distilled water, and pour the solution in the water to be tested. The effect will be the same.

Chlorine. In the case of wells suspected of contamination by sewerage, the organic matter present is easily shown by the detection of chlorine, which is in state of combination with sodium, forming common salt. Still the presence of chlorine in well waters from the western part of the state, cannot be taken as evidence of the presence of sewage contamination, since some of the mineral, alkaline ingredients are in combination with it in a natural state, sometimes even forming common salt. Add a few drops of pure nitric acid, then nitrate of silver: a white, cloudy precipitate or turbility will result. [For solution of nitrate of silver, obtain 1 dram in 1 ounce of distilled water; cost, with bottle, about 25 cts; pure nitric acid 20 cts.]

Sulphuric Acid, [most commonly with lime or magnesia.] Add a few drops of pure hydrochloric acid; then chloride of barium; a white, heavy precipitate will form. [For solution of chloride of barium, get two drams, in two ounces of distilled water; cost about 10 cts; pure hydrochloric acid, 15 cts.]

VII.

THE UPPER MISSISSIPPI REGION.

A REPORT BY O. E. GARRISON.

Prof. N. H. Winchell, State Geologist:

SIR; In the following report I will give a succinct narrative of the journey taken by me during the past summer to explore the head waters of the Mississippi R. in the interest of the tenth census of the United States, Dept. of Forestry.

This paper is compiled from notes made in pursuance of instructions given in your letter of the 23d of June 1880. In the accompanying map I have included the country traversed and have endeavored to represent the surface geology of the region as observed at various times during the last 20 or 23 years.

With one assistant as canoe man and man of all work, I left St. Cloud via Northern Pacific R. R. June 28, 1880, arriving at

Camp No. 1, Verndale, Wadena County,

on the same day, at which place we remained two days, taking notes of the forests, etc. Your own published observations render any of mine superfluous. Leaving Verndale we put canoe in the Wing R. at about one mile from the station near where a mill was in process of erection. The dam gives about 10 feet head and the excavation for the foundation exposes the stony clay so often described at about 10 feet below the surface which here consists of a sandy and gravelly clay.

Camp No. 2, Wednesday, June 30,

was pitched on a spot of gravelly clay 10 feet above the flood plain thrown up in digging a mill-race, near where the line of Tps. 134

135 crosses the river. The dam having been carried away, the site is now abandoned. In the race the boulder clay appears near the surface which is a rolling sandy and clayey loam. The timber consists of scattering black pine, *Pinus banksiana*, small Norway pine, *P. resinosa*, with a new growth, chiefly of deciduous varieties, as black and burr oaks aspens and birches.

Camp No. 3, Thursday, July 1.

Entered Leaf R. at 9½ A. M. and the Crow Wing at 4 P. M. The Leaf R. seems to be, approximately at least, a dividing line between fine stratified sand on the north, and sandy or gravelly clay on the south. I took occasion to examine an old fortification which I discovered and surveyed in 1869 of which I enclose a sketch showing plan and elevation (*Fig. 1, Plate 1*). Some three or four miles north of this place I discovered what appears to be evidence of a former settlement. I think these are the sites of a winter camp of one of the early explorers of this region.

The flood plain of the Leaf R. has an average width of 60 rods and is thickly covered by a growth of deciduous trees, while the conifers occupy almost exclusively the upland. The timber on the bottoms is chiefly elm, oak, soft maple, ash, and ironwood, while by far the most abundant among the conifers is the black pine, *Pinus banksiana*. The river at its present stage is from two to four feet below the surface of the flood plain. Camped on a bluff 15 or 18 feet above the Crow Wing R. in sec. 1, T. 134, R. 33.

Camp No. 4, Friday, July 2.

About a mile above the Farnham Brook is a bluff 42 feet high, where a recent land slide reveals the character of the drift. The top consists of a layer, 3 or 4 feet thick, of sand with no large pebbles mixed with vegetable mould; below is a layer of white sand 2 ft. thick followed by a layer of 6 feet of coarse sand and gravel with rounded pebbles. A layer of quicksand 6 or 7 feet thick rests upon the boulder clay which extends below the river bed.

The surface is rolling with few large boulders. Camped in sec. 2, T. 135 N., R. 33 W.

Camp No. 5, Saturday, July 3.

Soon after leaving camp No. 4 the river changes radically in the nature of the channel and bluffs. The former is obstructed by bowlders while the current becomes quite strong. The bluffs are sloping, and closely wooded and strewn with bowlders of granite, horblende and occasionally of limestone. The country retains the same general aspect as below. Groves of Norway and occasional white pine are interspersed among the characteristic black pine. There are also a few burr and black oaks. On the bottoms are the ash, elm, oak, aspen, spruce, balsam, fir, soft maple etc. In sec. 3. T. 136 N., R. 33 W. on the left bank of the river near the head of a rapids are two ancient mounds. I landed and made the following rough measurements: The one nearest the river is 56 paces from the top of the river bank, here about 12 ft. high; its longest diameter is nearly parallel with the course of the stream; the shape is oval, the longer diameter being 45 ft. and the height 4 ft. The second mound is 33 paces farther west, having about the same size and direction as the first, but is somewhat higher. North of both is a depression as if the earth had been excavated in making them. The soil is sandy with no boulders except in the river channel where they are large and numerous. Camped in sec. 5. T. 136, R. 33.

Camp No. 6. Sunday, July 4th.

Lay in camp all day. The bluffs have continued to decrease in height since leaving Camp No. 4, where they were from 30 to 50 feet high, while here they are only 5 or 6 feet high, with sloping banks, overgrown with grass and hazel. Very few boulders. Many red oak trees 20 to 30 feet high, 12 to 18 inches in diameter with an occasional black oak. A few rods back from the river, the characteristic black pine and sandy rolling surface.

Camp No. 7, Monday, July 5th.

The river retains the same general character as on Saturday, the stoney clay approaching nearer the surface. The oaks, aspens, elm ash are oftener seen on the uplands but the country a short distance from the river is the same as lower down the stream. At about the middle of the afternoon, however, after passing through a tamarac swamp and meadow in the northwest corner of sec. 37 R. 33, we found the bluffs higher, 10 or 20 feet above the flood plain. The flood plain is 40 to 60 rods wide, covered with willow thickets. About 80 rods east of camp, is a sink hole similar to those found in limestone countries, 30 feet deep with water at the bottom, fringed with a dense growth of willow and alder.

Camp No. 8, Tuesday. July 6.

Camp on a narrow neck of land between two lakes in Sec. 6, T. 138, R. 34. The country passed through to-day was similar to that already described until we reached the junction of the Shell and Crow Wing rivers, the former coming in from the west, the later from the north. The country lying north of the one and west of the other is radically different. The surface is quite level or gently rolling with rich, black gravelly loam. The characteristic tree is still the black pine, but there are also many small bur oaks with aspen, birch and ironwood, with small prairies and openings. These openings have a character peculiar to themselves. As throughout the west the bur oak openings were considered choice locations by the early immigrant, so here the *black pine openings* with the small prairies are the choice places, and are fought for by the different factions of Homestead Protection Societies.

This peculiar tract of country commences near the west bank of the Crow Wing river where it runs south through towns 139 and 140, R. 33, and extends northwest to the range of hills dividing the head of the Otter Tail or Red river from the Shell. The Shell river forming its southern boundary it extends north to a line of hills bearing N. 80° W. and crossing the 10th, standard parallel to the north of Fishhook lake.

Camp No. 9, Wednesday, July 7.

At 8.30 A. M., we arrived at a settlement known as Mantersburg on section 20, T. 139, N. R. 34 W. Mr. Jaris Howard gives the following data concerning a well sunk by him—depth 36 feet. 3 feet sandy or gravelly loam, 28 feet sand and gravel followed by quicksand bearing water. Other wells reach the bowlder clay at from 32 to 42 feet.

Camp No. 10, Thursday, July 8.

Went by team to Fishhook lake, distance of 9 miles. Eastward from Fishhook R., is a heavy growth of black and Norway pine, but after crossing the river not far from its confluence with the Shell, and ascending a bluff 66 feet high, we entered Fishhook prairie, one of the largest prairies in this belt of openings. The shore of the lake near camp, is sandy with a few water-worn pebbles rarely two inches in diameter. Among the stones I noticed colored slate of a schistose and sandy nature, sandstone, granite, a few quartz pebbles and perhaps 25 per cent. of limestone pieces.

The following trees and shrubs were noted:

Pinus banksiana, Lamb.
P. resinosa, Ait.
P. strobus, L.
P. mitis, Michx.
Fraxinus americana, M.
F. sambucifolia, Lam.
F. viridis.
Ostrya virginica, Willd
Prunus pennsylvanica, L.
P. serotina, Ehr.
P. virginiana, Marsh.
Virburnum lentago. L.
V. opulus, L,
Corylus rostrata, Ait.
Betula papyracea. Ait.
Populus tremuloides, Michx.
Quercus macrocarpa Michx.
Q. bicolor, Willd.
Q. coccinea, Wang. var. tinctoria.
Ulmus americana, L.
Salix, 3 or 4 species.
Ribes hirtellum, Michx.
R. rubrum, L.
Alnus incana, Willd.
Rhus toxicodendron, L.
R. typhina, L.
Amelanchier canadensis, T. & G.
Zanthoxylum americanum, Willd.
Crataegus crus-galli, L.
C. americana. Walt.
R. nigra, L.
Populus balsamifera, L.

Camp No. 11, Friday. July 9.

We loaded the canoe and crossed the lake to the inlet, which has an average width of about four rods, and a rapid current, while the water is of a whitish color. Many large bowlders covered with a white incrustation, obstruct the channel.

The country north of the lake radically changes in character, instead of a level or gently rolling surface, it is a hilly and broken region, many of the hills are abrupt and 100 to 150 feet high, the hollows occasionally having ponds in them, but generally having a grassy or bushy bottom, mostly of willow and alder. The timber changes to correspond with the surface, the diciduous varieties being in excess of the pines. The conifers are principally Norway and white pines, spruce, balsam fir, &c. About one mile from Fish-hook lake we reach the "falls." Here the water passes over a compact ledge of bowlders and in about ten rods has a fall of 10 feet, necessitating unloading the canoe to carry around. Both above and below the falls are rapids, so that within forty or fifty rods there is a descent of 18 or 20 feet. Hight of a hill near the falls on the left bank, 116 feet by barometer measurement. The rocks in the falls and above, are thickly coated with the whitish incrustation. Entering the lake in T. 141, of R. 34 and 35, we passed near ohe shore, which is thickly strewn with granite bowlders, and camped on a sandy point in section 26, T. 141, R. 35.

Camp No. 12. Saturday, July 10.

Passing up the inlet about 6 rods we reached a second lake and after passing through this we entered another inlet, and after rowing 80 rods and passing a rapids, entered a third lake, on the north shore of which is some good pine, though the decidiuous trees are larger and in greater variety.

Rowing up the western arm of the lake we landed, and guiding our course by compass, undertook a portage to a small lake 1½ miles to the northwest, camping in an opening a little south of the lake.

Camp No. 13, Sunday, July 11.

Remained in camp all day. Blue berries and winterberries are abundant.

Camp No. 14, Monday, July 12.

Much of the day was consumed in portages and searching for Indian trails. The country traversed today was diversified with hills 100 to 150 feet high, among which were occasional pools of water. The trees were chiefly of the different varieties of pine with dense undergrowth of hazel, willow, alder and an occasional black oak shrub.

The soil is a coarse sandy loam with occasional boulders.

Camp No. 15, Tuesday, July 13.

Making our way through several small ponds and inlets with an occasional "carry" through a dense growth of oaks, elm, basswood, aspen, black haw, shadberry, ironwood, hazel, etc., we reached a lake crossed by the line of ranges 35 and 36 of Tp. 142.

From the north end of the lake I was informed a trail is to be found leading to Itaska L., but after diligent search, no trail was discovered, and it was deemed prudent to retrace our steps and make the journey by the wagon road. To the north and northeast is a fine growth of pine, but to the westward the land was burnt over and less thickly wooded. The surface is hilly and rocky, large boulders often covering the ground. Taking a short trip inland, found the timber dense, chiefly white and Norway pine with aspen and a few oaks and maples, the latter only a shrub, 12 to 18 feet high, growing in clumps as if from the stumps of old trees now wholly disappeared. The surface soil is stony clay.

Camp No 17, Thursday, July 15.

Arrived at 1½ p. m., at Camp No. 10, and waited for one of my men to secure a team to transport our luggage to White Earth Agency.

Friday, July 16.

The whole day consumed in waiting for the promised team, but at evening we engaged a team and driver so as to start to-morrow.

Camp No. 18, Saturday, July 17.

Passed numerous settler's cabins. Of several wells noted, the following description of one sunk by Mr. Samuel Churchill on Sec. 26, T. 140, N. R. 35, is typical—12 ft., sandy loam, about 4 in. sandy clay, 1 ft. gravel and sand interspersed with small, rounded stones, coarse sand to water which was 3 feet deep. Passing the eastern boundary of the White Earth Reservation we enter a level country with rich, sandy loam and no stones. The black pine becomes less abundant, good size bur oak with small aspen and birch and an occasional Norway or white pine taking its place. Five or six miles further on we entered a hilly, sandy tract covered by a thick growth of small black pine, where we camped.

Camp No. 19, Sunday July 18.

Resuming our journey we ascended a hill higher than that on which we camped, and found ourselves upon a level table land, where the soil was less sandy and supported an undergrowth of hazel and alder, while the open spaces were gay with the scarlet and yellow leaves of the painted cup. We there found about two miles of rolling ground where the black pines almost wholly disappear and young dense growth of aspen, birch, oak, ironwood, red, black and choke cherry, shadberry, alden and willow with some Norway pines supply their place. Soon afterwards we passed a rocky ridge with many white pines among the Norway and black varieties.

South of the road was a lake in a steep valley about 75 feet below the road. Hills surround the lake on all sides but the northwest. Descending these hills to the west we entered a rocky rolling country where the timber was more of it of the deciduous kinds with some medium sized white and Norway pines, which increased in size and number till they formed a fine grove of good marketable pine timber. There were also seen some sugar maples and oaks. As we passed on west the maples increased in size and frequency while the oaks, birches and elms, many of them reached a large size. We passed several lakes, on the shore of one of which and in the road near it many small pebbles of limestone were seen quite half of the pebbles being limestone. This lake is in a deep valley; after passing it and crossing its outlet we passed over a high, rocky ridge, where were boulders of a large size, many of them being 4 to 6 feet across on the exposed top. These boulders are mostly granite. No limestone was seen. This hilly rocky tract continued about five miles when the pines gradually thinned out and disappeared, and large oaks, sugar maples, birch, aspen, cottonwoods, balm of Gilead, elm, ash, ironwood, etc., formed a splendid forest. The hills were twenty to forty above the hollows where were occasional ponds or lakes. The soil is a clayey loam, in the level spots, free from stones and wet and muddy, but boulders nearly cover the surface on the sides and tops of the hills. This continues until within one or two miles of the Agency when the tall timber begins to thin out and the most of the trees are bur oak. The hills are less high and steep, the hollows covered with a thick, tall growth of grass forming fine natural meadows. Indian farms were passed, and we soon entered a well cultivated region, the surface gently rolling with but a few stones; soil, a rich black clayey loam.

Camp No. 20, Monday, July 19.

After procuring the needed supplies and directions at the Agency began our return to the Junction of the Itasca road with that upon which we had come. We entered camp at the crossing of what I take to be the principal branch of the Otter Tail R. The following is a list of such trees and scrubs as I have been able to identify during our hasty journey from here to the Agency and back:

Quercus, alba.
Quercus macrocarpa.
Quercus tinctorea.
Fraxinus americana.
Fraxinus pubescens.
Fraxinus viridis.

Quercus bicolor.
Quercus ambiqua.
Ulmus fulva.
Ulmus americana.
Betula papyracea.
Betula nigra.
Populus tremuloides.
Populus monilifera.
Populus balsamifera, var.
Populus candicans.
Viburnum prunifolium.
Viburnum nudum.
Viburnum dentatum.
Viburnum acerifolium.
Viburnum opulus.
Rubus strigosus.
Rubus occidentalis.
Rubus villosus.
Rubus canadensis.
Rubus cuneifolius.
Prunus americana.
Prunus pumila.
Prunus pennsylvania.
Prunus virginiana.
Prunus serotina.
Alnus incana.
Alnus serrulata.
Abies nigra.
Abies alba.
Vaccinium pennsylvanicum.
Acer saccharinum.
Acer dasycarpum.
Acer rubrum.
Pinus strobus.
Pinus resinosa.
Larix americana.
Ostrya virginica.
Carpinus americana.
Viburnum lentago.
Sambucus canadensis.
Lonicera grata.
Lonicera parviflora.
Diervilla trifida.
Rosa lucida.
Rosa blanda.
Crataegus crus-galli.
Amelanchier canadensis.
Amelanchier var alnifolia.
Spiraea salicifolia.
Spiraea tomentosa.
Dirca palustris.
Salix, three or four species.
Corylus americana.
Corylus rostrata.
Tilia americana.
Rhus glabra.
Zanthoxylumamericanum.
Arctostaphylus ura-ursi.
Vaccinium corymbosum.

Camp No. 21, Tuesday, July 20.

After ascending the divide between the waters flowing east to the Shell and Crow Wing rivers and those flowing west to the Otter Tail we reached an Indian village consisting of temporary huts and lodges where the Indians are collecting Senaca snakeroot (*Polygala senega*). Many hundred pounds of which are stored in the warehouses of the traders. This camp is situated in Sec. 33 T. 141, R. 37, and the black pine openings extend to the west and north as far as the eye can see.

We were here informed by the trader that no such road as we were told of exists toward Itasca but offered to take our load to a lake about 8 miles north of the camp to which the Indians go with wagon to fish.

I have noticed the lead plant *Amorpha canescens* for the first time since leaving St. Cloud.

Camp No. 22, Wednesday, July 21.

Started by 10 a. m., after crossing the prairie towards the north and disovering a valley about 20 feet deep, we climbed a line of hills bearing about N. 80o W, and about 50 feet above the prairie level. The southern aspect is quite steep and full of boulders. The top is gently rolling sand with a few boulders and timbered with small black pine, which forms quite open woods with undergrowth of hazel, aspen, willow etc, By 1½ p. m. we reached the lake crossed by the line between Towns 141 and 142, section 5 32, the south end of which is over 9 miles from the nearest point on Itaska Lake. The outlet of [the lake is a branch of Fishhook river. The bottom of the lake is in many places of the whiteish color noted when crossing the first lake north of Fishhook Lake. Camped at the north end of the lake in a tall dense growth of sprube, birch, aspen, elm, basswood etc., with a dense undergrowth of hazel, plum, willow and alder. A grassy pond fenced in by an old beaver dam on which our tent is pitched, lies a few rods from the lake.

Thursday and Friday, July 22 and 23,

were spent in making the portage from the lake mentioned above to a pond through which the main branch of Fish Hook R. flows, in T. 142, Sec. 17 and 20. This pond is in a valley diversified by such ridges as are known in Wisconsin as "hog backs." Loading canoe a little to the west of the pond, in the brook, we crossed the pond to its outlet, a comparatively large lagoon-like, sluggish stream filled and overgrown with rushes and lily pads, course nearlv northeast for about ¾ of a mi., when the brook takes a sudden bend to the south, cutting its way through hills 75 feet high. while the valley continues northeast, and a small brook comes from it, joining the larger part at the bend. Here we again packed and carried to a high pine ridge north of the valley.

Camp No. 24, Monday, July 26.

The accidental destruction of part of the stores and equipage having necessitated a delay for repairs we were only able to resume our journey this morning, putting the canoe afloat in the pond north of the ridge, after crossing to the north side of which we began the portage to a lake in Sec. 3, T. 142, R. 36, about two miles distant. Our journey was through dense woods of black and Norway pine with hazel. alder. willow and aspen undergrowth.

Camp No. 25, Tuesday, July 27.

Completing the carry over a gently rolling country. with gravelly surface with now and then a bowlder of granite. we ascended a rise of about 30 feet and descended about 88 ft. to the shore of the lake mentioned. The lake has several islands whose shores like its own are gravelly. This series of lakes is marked on the old maps as having an outlet to the north and thus flowing into L. Itaska being therefore the ultimate source of the Mississippi. Crossing this lake we encamped at the east end of a trail leading to a lake due west about 30 rods.

Camp No. 26, Wednesday, July 28.

We carried over to the other lake. then paddled slowly near the shore. soon coming to a landing and trail leading north: going on in search of the outlet of these lakes. we passed several low spots in the hills surrounding the lakes (20 to 30 feet high). Failing to find an outlet we returned to the place where the trail leading north was found. Here we had a carry. about forty rods. over a low hill, then a pond 60 or 70 rods, then a carry over another low hill 40 or 50 rods, then a pond 50 or 60 rods. dining among some large Norway and white pines. with oaks, basswood, maple &c.; after dinner a carry of 60 or 70 rods to a pond crossed by the line of government survey between secs. 27 and 34. Near the north end of the pond 50 or 60 rods over the floating bog. northeast of the pond, found the usual marked trees at the beginning or ending of a carry. The trail was easily followed through the swamp, but after leaving the swamp and beginning to ascend a low hill we entered a dense tall growth of birch, aspen, oak, pine. &c.. the ground thickly strewn with the remains of a large growth of pinea. many of them still pretty sound, showing there was, but a few years ago, a large pine forest here. To the north about half a mile was seen a grove of Norway pines. still alive. through which it seemed that it would be easier to cut our trail. We therefore went into camp. On the northwest end, among tall tamaracks and the end of the swamp. was an old beaver dam on which was growing a dense thicket of alders and willows. In this dam was an opening about two feet wide, through which was running water about two inches deep. I followed this brook about twenty rods down a rapid descent, with numerous bowlders where the channel was choked with fallen timber, to a mossy pond, or rather to the mossy bottom of a small pond now dry, which stopped my further progress. I consider this the largest feeder to Itaska Lake worthy to be considerd as the utmost source of the Mississippi River. Our route to-day has been over a gently rolling country, with some large pine trees and an occasional oak, elm, basswood, &c., many bowlders on the hills

Camp No. 27, Wednesday, July 29.

Started to make a trail to Elk Lake. Found the way very brushy and crossed a large swamp, surface gently rolling until within about one quarter of a mile of the lake, when we ascended a hill 50 or 60 feet high, on the top of which I climbed a tree to view the surrounding country. For many miles in all directions but the north the surface was gently rolling, none of the hills appearing to be more than twenty or twenty-five feet high; they were chiefly covered with a young growth of birch, aspen and a few oak. Towering above them were seen the black pines, not killed by fires, and an occasional single tree or small groves of Norway pine, towering still above these. These fires which so devastate and utterly ruin so many thousand acres of large pine forests are said to be set by the Indians, purposely, and assisted to spread, to kill the timber, and so give better feeding ground for the moose and deer which abound in this vicinity. The swamps are covered by a large growth of tamarack, spruce and balsam fir. Saw several mountain ash, and there were large tracts covered by the juniper, *Juniperus sabina,* now with ripe fruit. Very few boulders were seen on our route. Directly north of the tree on which I was then was a low spot concealed by a grove of Norways, where was Elk Lake and to the north of this, Itaska. By 1 P. M. we had cut a trail back to camp and, after dinner, carried our first load over to Elk Lake, where we arrived just in time to put up tent and keep dry during a smart shower.

SERIES 2.

Camp No. 1, Friday, July 30.

Completing the portage, by 3 P. M. we were on Elk Lake, steering for Itaska, about one mile distant, as indicated by an open space in the line of low hills. The outlet was soon found; the water was low and a few rods down from Elk Lake the canoe stranded on the pebbly bottom of the brook; landing and ascending a low hill on the left, Itaska Lake was seen for the first time, about forty rods north. The hill or mound-like elevation is of an oval shape about twenty feet above the lake, and is near the center of an open space, between Elk and Itaska Lakes, of about twenty-five or thirty acres. Several pits on the sides or top had the appearance of old cellars and probably indicated where houses once stood, but all traces of timber if any was used in such houses have disappeared and the numerous boles of large oaks strewn over the ground indicates that there could not have been much cultivation. Still many patches free from standing or fallen trees and a thick mat of grass or wild strawberries, covering from one to four or five acres were quite evidence enough to show that there were once Indian gardens here. Between this open space and the lake shore was a line of trees still standing. Carried over to the lake about 40 rods, and embarking on the lake, pitched camp on a point on the west shore.

Camp No 2, Saturday, July 31.

We paddled slowly along the west shore of the northeast arm, stopping occasionally to identify trees. The arm of the lake towards its southern extremity is surrounded by comparatively high hills, the highest probably 75 ft. above the lake. The western shore is badly burned, with but few pine trees standing, and the dense new growth of birches and aspens among the fallen trees makes it a very difficult tract to traverse. The eastern is much less devastated by fire. There is some good pine on the sides of the hills which, near the southern extremity may reach 100 ft. above the lake. The shores of the southwestern arm are low, 10–15 feet high, and closely fringed with spruce, cedar, balsam fir and tamarack. Some boulders were seen, while the east side of the southeast arm is lined with rocks, and the side hills quite covered with fair sized white and Norway pine. At our camp the soil is a sandy or gravelly clay. The shallows entirely round the lake are grown up with rushes, reeds, wild rice, lily and flag leaves to a distance of 10—60 rods from shore.

Camp No. 3, Sunday, August 1.

Starting about 8 a. m., we reached the outlet of the lake where the Mississippi first takes its name, by 9½ A. M. It is here an insignificant stream of less width than the length of my canoe. There is a perceptible current and 18 or 20 inches of water with a soft muddy bottom and shore: the banks are low and level and brushy, bordered with prairie country with a few black pines. Continuing on, we soon came to where the stream was too shallow to float the canoe and to a width of less than half the length of the canoe, in several places. We had to lift the canoe over sand bars; we also had to cut away several recently fallen trees that obstructed the channel. Numerous old cuttings showed long use of the river for boating, though no fresh cuttings were seen. About two miles from the lake the river enters a tamarack swamp where it has a deep, broad and sluggish channel, frequently nearly closed by a large growth of wild rice of which many hundred bushels could be gathered. In many places the banks were lined with sweet flag, *Acorus calamus,* L., and good meadows of blue joint and red top, *Calamagrostis Canadensis and Agrostis vulgaris*, With., where thousands of tons of hay could be made. This swamp continues for about three miles, but the river meandering through it is more than twice that distance. A short distance after leaving this swamp we came upon a jam of drift-wood which proved to be the head of a falls or rapids, where the river by a series of short leaps over compact ledges of boulders, has a descent of about twelve feet in as many rods.

This was a surprise as I had the impression from all the information I had, that from the Falls of Pokegama up to Itaska Lake, there was no obstruction to the free passage of canoes.

Following down the bank of the river, I found a series of rapids over boulders for nearly half of a mile, when the river enters another swamp of tamarack and spruce, but without the usual meadow on the bank. The trees which had fallen across the river had been cut away, proving its use, for the passage of boats.

The country is rolling, the hills of gentle ascent, except the bluffs on the river where they are steep and, at our camp, forty-six feet high by barometer measurement. The general level is about that height above the river, the highest hill seen would not exceed 25 feet higher. The country is open, low and brushy, with a few clumps of Norway and black pine; boulders of granite are quite plenty on the hill sides; the surface soil is a gravelly clay.

Camp No. 4, Monday, August 2.

"Carried" down to the landing found yesterday and loaded canoe. We soon came to fallen timber obstructing the channel and had to cut our way through many *jams* of drift wood in many places; also boulders so obstructed the channel that we had to get out of the canoe and wade, lifting over the rocks. In this way we made slow progress, and by noon, from the appearance of the country we had not made much more than two miles northing. While cook was getting dinner I went back from the river about half a mile; found the surface quite level. The black pine timber was burned and fallen; the new growth principally birch and aspen, and a few black oaks. The soil is a sandy or gravelly clay. No rocks seen except in the river; the bluff, about 20 feet high. The flood plain is twenty to forty rods wide; the channel of the river two to four feet below the flood plain.

Soon after starting in the P. M. the bluffs increased in hight; the river seems to have cut its way in a narrow gorge, through hills seventy to eighty feet high. Camped on a terrace or old flood plain about fifteen feet above the present channel.

The timber on the narrow flood plain is a tall growth of spruce, balsam, apsen, balm of Gilead, a few oaks, elms, and ash; on the upland are the usual burnt and fallen black pines; on the left is a tamarack swamp about half a mile from the river, while on the right bank there is less burnt land and some good white and Norway pines.

Camp No. 5, Tuesday, August 3.

The stream was found much obstructed by fallen trees and rocks until we entered a narrow tamarack swamp where the water is deep enough to float the canoe. The swamp soon widens to about eighty or ninety rods with meadow near the channel of the river. We took dinner on a point of hard land projecting into the swamp from the left, where there was an old, much used camping place and a trail leading to the northwest. This trail I suppose to be the one leading from the Mississippi to the upper Rice Lake, the outlet of which is Rice river, a feeder of the Red river and about four miles distant. The swamp was wide at this point and below, but in about a mile the bluffs on each side were seen to be ten to twenty feet high and clothed with tall Norway and black pine, leaving a flooded plain about 60 to 80 rods wide. The river has cut a channel in the soft, mucky bottoms from four to six feet deep.

Camp No. 6, Wednesday, August 4.

The river enters a wide meadow and has cut its way in a very crooked channel from four to eight feet deep. I noticed in many places below the black mucky soil, a white clay, of which I have a sample marked No. 1; it was taken from a depth of about 6 feet below the surface of the flood plain in the river channel. The outer bluffs were about 10 to 12 feet high, with many groves of tall Norway pine forming open woods. The soil a sandy loam; and when the river infringes on them shows a stratification. Soon a line of hills appeared in the north, two or three miles distant, the river gradually approaching them and by 9.30 A. M. we reached them. The river has cut its way in a deep narrow valley, the bluffs rising fifty to seventy-five feet above the river, which has a rapid current obstructed with bowlders. The timber on the bluffs, black and Norway, with a few white pines and bur oaks. After passing through these hills about one mile, we entered another broad meadow or savanna, through which the river meanders in a very tortuous way, prevented from reaching the outer bluffs by a tamarack swamp of unknown width. Took dinner on a low projection of dry land in the meadow, in section 28, T. 146, N. R. 35, W. 5th M. From here another line of hills is seen north of east. By 5 P. M. came to the first low bluff on the right bank, in section 34, T. 146, R. 35; here the almost boundless meadow was narrowed: the bluffs, twenty to twenty-five feet high, lined the flood plain to an average width of 60 to 80 rods. Camped on a bluff nearly opposite a small brook, entering the Mississippi from the south, in section 35, T. 146, R. 35. A few oaks were seen on some of the low points of dry land projecting into the meadow through the tamarack, and the river bank was often lined with tall willows, while, in other places, tall reed grass completely closed in the channel.

Camp No. 7, Thursday. August 5.

Soon after starting we entered another broad savannah. This continued until near noon, when another range of hills was entered. Took dinner on a bluff 49 feet above the river, by barometer measurement—the highest seen. In passing these hills there was an occasional rapid with large bowlders in the channel; deciduous trees are more frequent and of large growth. The flood plain after passing through a narrow valley of about three-fourths mile, again widened and was bounded by bluffs fifteen to twenty feet high. The country is gently rolling with open bushy plains, bearing some small black pines. The soil is a sandy loam, the river often exposes the stratified sand on the banks; for about two miles before camping the flood plains become narrow—40 to 60 rods wide—and in many places are covered with a thick growth of soft maple, elm, ash, oak and aspen. Camped on a bluff of a very regular crescent shape, 49 feet high by the barrometer, section 17, T. 146, R. 33.

The country south of camp is quite level and free from brush, while the many fallen trees, and the tall stumps of many more blackened by fire tell that not very many years ago there was here quite a dense forest of pines; I went back to a couple of rounded hills about half a mile from the river. From the top of these the country for ten to twenty miles was mapped. To the south and west was a gently rolling table land bounded on the south by a range of hills of fifteen or twenty miles distant. To the east and north the land seems to descend with a gentle slope, and is quite level, clothed with a greener foliage of trees than seen since the forests of the Partridge and Wing rivers were passed. To the south and east was a deep valley in which were seen two large lakes. The soil is sandy with a small young growth of birch, aspen, and a few bur and black oaks, while the black, red, sand and choke cherry are plenty, and are now loaded with ripened fruit. Blackberries, strawberries, red and black raspberries were also in abundance.

Camp No. 8, Friday, August 6.

Soon after starting this morning, we passed the junction of a river nearly as large as the Mississippi. At their junction the Mississppi turns at a right angle and takes the course of its tributary. At 9.30 A. M., we entered the first lake through which the Mississppi runs after leaving Itaska. The next lake, the Pa-ma-jig-er-mug of the Indians, and Cross lake of Nicollet, is a larger lake, and the first one seen since leaving Fishhook lake whose shore has not been grown over with rushes, reeds and wild rice, &c. At the inlet of this lake there was also an Indian's farm or garden, where were corn, potatoes, pumpkins, squashes, &c.; his squaw who came down the lake and landed here, was the first human being we had seen since the Indian left us and canoe with his pony on the 21st day of July last. After crossing this lake, the river is rapid and full of rocks, making at the present low water a difficult matter to run the canoe down without striking rocks. The shores of the river here are sloping, with a flood plain little or no wider than the river channel; the bluffs are from ten to thirty feet high. There are some bur and white oaks, with many elms, ash, balm of gilead, aspen, &c. We here passed a cedar swamp on the left bank. The country is quite level or gently rolling; the soil is a gravelly clay; the sand bluffs of landslide make, have not been seen since the junction of the large stream before mentioned, and the timber is more of it white and Norway pine, with many deciduous varieties. In the P. M. there were fewer bowlders seen in the river, but the water was deeper and the current rapid. For about two hours before camping, the flood plain widened out and formed large meadows with willow and alder. Camped at 7.30 P. M. on a kind of terrace about six feet above the river as it is at this time, where there are many bur and white oaks, and some large Norway and white pines.

Camp No. 9. Saturday, August 7.

The river here soon runs through the north end of a lake. The western line of the great Indian Reservation of the Leech lake, the Winnebigosis and Mississippi bands of Chippeways commences here; and soon after passing the lake we came to an Indian village of bark lodges, at the entrance of a small lake; on the other side of which was seen another Indian village while far to the north was another still. The soil around these lakes appears to be of an excellent quality, producing corn, potatoes, beans, squashes, &c., in good measure, considering the Indian mode of cultivation. Beyond this lake we crossed another that we at first took to be Cass lake, but after about two and a half miles to what we supposed to be the outlet of Cass lake, we passed a narrow point, and the broad surface of Cass lake lay before us. This is the largest lake but one, through which the Mississippi flows until it reaches Lake Pepin, the Winnebigosis being the larger. The banks of lake Cass are low; no hills that I should judge to be over thirty feet high, border the lake; the water was shallow for a long distance from the inlet, Camped about ten miles below the lake. The river here is very much larger than above Cass lake. The bluffs are sloping and bowlders are often seen on their sides. There are some fair sized oaks, elms and ashes, many large Norway and a few white pines. The black pines are less common, and the shrubs in much greater variety. The phænoganous plants, and grasses are of a ranker growth than seen elsewhere since leaving the black pine openings and woods of the White earth Reservation.

Camp No. 10, Sunday. Aug. 8.

Starting the usual hour. we came in sight of Winnibegosis by 10 a. m. The flood plain widens out to about ½ a mile for near two miles before reaching the lake. We took an early dinner where the river comes to the bluff for the last time before reaching the lake. Soon after entering the lake, we saw to the northeast a number of white specks on the shore; these indicated an Indian village. Steering our course as near as possible for the outlet of the lake and aided by a stiff west wind we crossed the widest part of the lake by 3 p. m., and by 4 p. m. entered the river at its outlet. We found some difficulty in finding the river in the large space filled and overgrown by tall reed grass at the foot of the lake. On the left bank near the outlet on a spot of flat or bottom lands, separated from the river by a marshy strip, fifteen or twenty rods wide, was an Indian village of about a dozen bark lodges with two or three log buildings, one of which had the appearance of being a church. On the right bank opposite the village was seen for the first time since passing the large tributary to the Mississippi on the morning of the 7th, one of the sand slide bluffs revealing stratified sand, with the boulder clay twelve or fifteen feet below the surface. The timber around the lake as seen from the canoe while passing was the usual black with many white and Norway pines, mixed with which were many deciduous trees. On the northeast shore there was a large tract of hard woods which I was desirious to explore, but as the time and expense have already exceeded my estimates, I did not stop. The river after passing the Indian village has a wide bottom or flood plain on which is a tall and dense growth of reed grass, and the channel divides, forming many islands on which is seen nothing growing but that grass. The outer bluffs are sloping, and many boulders were seen on their sides, while the oaks and other deciduous trees are of larger growth than seen above Lake Winnibegosis.

Camp No. 11, Monday, Aug. 9.

The river below our camp of last night, for three or four miles meanders among tall reed grass, the bluffs about half a mile apart: then the flood plain contracts to 60 or 80 rods wide with boulders on the sloping bluffs and in the channel. The flood plain again widens to one half or three miles, and the river winds from side to side through the tall reed grass. The channel is full and overflowing. At the junction of the Leech-lake river, the Mississippi turns at a nearly right angle and takes the course of its tributary. The timber after the Leech-lake river joins, consists more largely of the hard woods; birch, oaks and aspens prevailing. Camped on a bluff about 30 feet high. From the top of the bluff is seen to the north and northeast the low lands surrounding Ball Club Lake, a tamarack swamp concealing the lake from view, while to the east and southeast stretches a large marshy meadow of many miles in extent, over which a line of hills, blue in the distance, indicates the hilly region in which is situated Deer and Bass lakes, where is said to be many millions of feet of peculiarly fine white pine. Far to the north of our Ball Club Lake the low lands extend to Bowstring Lake through which the Big Fork river runs in its course north to the Rainy Lake and River. Mr. J. P. Hinchelwood, a former U. S. Deputy Surveyor informs me that from a point near the southern most part of the latter lake, there is low ground extending south, where during high water there is a water connection with a river that runs west and north entering Lake Winnibegosis at its northern extremity.

Camp No. 12, Tuesday, Aug. 10.

Soon after stsrting we entered the great morass and meadow on the north and west of White Oak point; passed the point at 10 a, m., stopping a few minutes to examine the surface and timber. There was here, a few years ago, a prosperous Indian settlement.

When Jas. Whitehead was the Indian Agent he had his residence here. Leaving the savanna about 12½ p. m., found the first accessible landing on hard ground, except at the White Oak point, since leaving the camp in the morning. Hundreds of tons of hay are now being put up by the Indians and half bloods, for lumbermen. Took dinner at an old log landing, where I gathered a rich harvest of specimens. There were more deciduous trees and of a thrifty growth than seen at any place on the river hitherto. At 4 p. m. passed a lumberman's camp and farm, where was a white man seen for the first time since leaving the trader's camp in the southeast corner of the White Earth reservation.

The banks of the river passed after dinner were of an average of 80 or 100 rods apart. In some places the flood plain widens to half a mile or a little more. Only in two or three places during the day were boulders visible in the river channel or on the bluffs. The bluffs were mostly low, six to fifteen or twenty feet high, clothed with live thrifty trees, the principal kinds being white and Norway pines, birch, aspen, white and burr oaks and a few black oaks, most of the timber being a new growth of fifty to seventy-five years.

Camp No. 13, Wednesday, August 11.

Arrived at Pokegama Falls at 10¼ P. M. taking notes, collecting, &c. Not having an instrument with which to measure the width of the river or accurately take the levels, contented myself per force with barometric hights. According to them the descent from the upper to the lower landing was 31 feet. On the right bank about 80 rods above the place where the rapids commences, sandstone in situ is seen. It is coarse, friable and of a reddish cast. The dip appears to be about 20° S. 75° E., and where the chute is most perpendicular, appears to have been eroded so as to allow the harder rock immediately superimposed to sink at a crack or fault, crossing the channel at nearly right angle, forming the smoother apron-like chute, where the fall is steepest. At its lower end it is broken and loose, where the water meeting with the obstruction rises in waves three or four feet, and then rushes in a boiling current over the loose rocks broken from the strata.

The pen and ink sketch in plan and section will convey a tolerably correct idea of the Falls and the strata of which the rock is composed. The numbers corresponding with the same on the paper, in which the specimen is enclosed. (Plate 1, Fig. 2.)

In about half an hour, paddling down the stream, we arrived at Grand Rapids, the head of steamboat navigation above Aitken on the Northern Pacific Railroad.

Above Pokegama Falls, steamboats could readily run to a point some miles above Lake Winnibegosis, also up Leech Lake River to Leech Lake agency. Indeed, in 1875, when Mr. J. B. Bassett was Chippeway Agent he built a small steamboat on Leech

Lake and used it to transport supplies to points above Pokegama Falls. Steamboats were run from Aitkin to this place, making trips as often as a load is obtainable, the lumbermen being the principal freighters. The bluff here is above fifteen feet above the river. The first bench or terrace, on which is built the store and most of the buildings is rocky, while back about twelve or fourteen rods, the land rises perhaps twelve or fifteen feet higher with fewer boulders. The soil is a clayey, sandy loam. The timber is principally pine, of that species or variety which I have often mentioned as *P. mitis,* the "Northern pitch pine." The oldest and most experienced lumbermen note the difference between this and *P. resinosa*: one is called by them Hard Norway, the other the Red-barked Norway.

Camp No. 14, Thursday, August 12.

Spent all of the forenoon collecting and mailing such conifers found in the vicinity not yet sent to professor Sargent. Then in the P. M. ran down to the mouth of Prairie River and up that to the first fall or rapid in Town 56, N. R. 25, W. 4th Mer. In ascending this river after leaving the Mississippi, the current is slow and the water deep, the channel taking a wide bend to the west then sweeps around to the east. On the present point formed by this bend there are some white and bur oaks, ash, elms, aspen, etc. Just at the base of this point the river has a north and south course, and a rapid over a boulder clay exposure. These rapids extend up stream about half a mile, when the river expands in a broad lake-like channel with wide borders of wild rice. For about four miles to near the foot of the lower falls the banks are low and bordered by cedar, aspen, balm of Gilead, oaks, pines, etc. As we approach the rapids below the falls the lake-like channel has many boulders and two or three small islands on which is some grass and shrubs. Owen in the description of Pokegama falls in his report of the geological survey of Wisconsin, Minnesota and Iowa, says that the continuation of the ridge which forms these falls, to the northeast constitutes the divide of the waters flowing north to Rainy Lake from the waters running south to the Mississippi and St. Louis. It appears that neither he nor his assistants were aware of the existence of these falls of Prairie river. The exposure of this rock which occasions the Pokegama falls appears to me to be a part of the same ridge forming the two falls of Prairie river. The rock exposure forming the upper falls, I have traced in a northeast direction over one mile, the upper falls and the lake between it and the lower fall being the result of igneous forces. The sketch of the two falls and lake between them is copied from one made by me from actual survey in August 1869. (Plate II, Fig. 1.)

These exposures of rock have been greatly disturbed and so altered by igneous forces that their dip is very difficult to determine. The only point where the dip is apparent is at the lower fall near the point marked 3 on the plot, where the water glides over the smooth surface at an angle of about 35° toward the south for about six rods: near the foot of this slope was taken No. 102 from the top, which, during high water is beneath the surface. The surface of the water in the upper lake above the rapids is about 10 feet higher than the lower lake. The lower lake is about 15 feet above the surface of the water in the river below the rapids at the landing at the beginning of the carry, making a total fall of some twenty-five feet. The trail from the landing to the lower lake is full of loose rock of altered—metamorphosed—sand stone. Specimen No. was from near the middle of the carry where the surface of the rock *in situ* was exposed: it was about 8 feet above the water in the lower lake. Near the foot of the lower fall there is a seam or vein of ironstone, Nos. 112, 113 and 114. The course of the vein is about N. 40° E. S. 40° W. and where exposed in the channel of the river lies nearly horizontal, while the dip of the rock is about 15° S. W. At about the middle of the channel where the ironstone is the most plainly revealed there seems to be a fault, over the edge of which the water has a perpendicular fall of about 18 inches while the containing rock retains its dip of about 15°: but both soon after disappear beneath loose boulders to again reappear on the left bank a little below the landing. The width, (10 ft.,) of this vein of iron is quite uniform as far as it is traceable. In the drift on the right bank some parties in prospecting have dug pits in a course in which this vein if extended would be found: the pits are 5 or 6 feet deep, from the bottom of which a specimen was taken.

At the upper fall the rock has been subject to a more energetic disturbance and is broken and dislocated in all directions so that the dip or course of any particular seam is difficult to determine. Many of these cracks are filled with a quartzyte conglomerate (Nos. 109 and 110.) At one point I thought that I saw an injection of trap when surveying in 1869, but after diligent search at this time failed to find it. I might have been mistaken then but my impression is that such a seam of trap was seen and specimens taken. The river here is contracted to a width of 18 or 20 feet, between perpendicular walls of rock 15 or 20 feet high. To the east of the river and "carry" the rock rises to a hight of about 50 feet above the surface of the water in the lower lake, and the ridge continues in a northeasterly direction, with frequent out-crops of the rock above the drift and soil covering it and then sinks beneath the swamp in section 26. Friday and Saturday were employed in collecting samples in the vicinity of the falls and lakes.

Camp No. 15, Sunday, August 15.

Started from Prairie river falls at 9:30 A. M. After entering the Mississippi, frequently landed on the points formed by the bends of the river in meandering through the wide flood-plain which are densely covered by a large growth of hard woods. On one of these points in town 54, N. R. 24 W. was rewarded in my search by finding a single tree of hack berry, *Celtis Mississippiensis*, Bose or *C. integrifolia* Nutt.: being without fruit could not decide which variety.

This is the most northerly point where I have seen this species. Mr. J. P. Hinchellwood tells me that when he was U. S. Deputy Surveyor, surveying T. 149, N. R. 26, W. 5th Mer., he saw several of the trees on the flood plains of the Big Fork, a tributary to Rainy Lake. Camped on a bluff 65 feet high by barometer measurement. The country west is a gently rolling, open brushy tract. About half a mile west is seen the remains of a large growth of pine in the shape of tall blackened trunks with a few live trees. The new growth is principally birch and aspen, a few oaks, with cherry, willow, alder, hazel, etc. Very little of it exceeds ten feet in hight while ferns and blueberries dispute for room with the grasses. The following rough sketch will give an idea of the formations as seen on the steep bluff revealed by land slides. (Plate II, Fig. 2).

Camp No. 16, Monday, August 16.

A dense growth of young aspen, birch, alder and willow surrounds our camp, which is on a kind of a terrace, the bluff in about eight rods rising about 15 feet. On our way to-day we saw bluffs from thirty to sixty feet high where the stratification was well shown which did not vary much from the sketch and description given above. In one place where the river swept around in a very regular curve of nearly half a mile periphyry and quite or more than a semi-circle, the bluff was about thirty-five feet high, and when near the middle of the curve there appeared above the water a bed of very compact clay, which had a dip up stream, the topmost layer continually rising above the water and appearing like a wall of irregular sized brick in regular courses, the courses being very regular. This layer seemed to end on the bluff ascending to a kind of terrace above the flood-plain, the second bluff also terminating some of the upper courses. (Plate II, Fig. 3).

The rough sketch will convey to the mind an idea of the appearance better than any description. The courses as represented are too thick and the dip too great; otherwise it is nearly as it appears from the river. The timber on the higher bluff is principally black and Norway pine and on the flood plain soft maple, oak, ash, elm, aspen, and willow, of which last I saw some large specimens. I also saw butternuts, the first seen on this trip.

Camp No. 17, Tuesday, August 17.

Began our journey at 7½ A. M. The river is very crooked. The timber on the flood plain increases in size as we descend the river. Passed the mouth of Swan river at 4 P. M. There has been a steam mill in operation here since I passed here the last time, but it has been removed with all the machinery, and no residents are here now. Camped on a bluff perhaps fifty feet above the river. There was a crew of hay makers camped there in charge of Mr. Libby, from whom I received much valuable information as to the standing timber in the vicinity. The soil on the left or west bank of the river is more clayey and boulders come to the surface. Cedar, spruce, balsam-fir, etc., are seen in dense woods, and crews of Indians and half-bloods are at work getting out cedar telegraph poles.

Camp No. 18, Wednesday, August 18.

The timber on the flood plain continues to increase in size; saw many large old oaks, ash, elm and aspens, many four to five feet in diameter. The yellow birch and soft maples are many of them three to four feet in diameter.

Camp No. 19, Thursday, August 19.

Passed the mouth of Sandy river at 8½ A. M. Landed to take a look at the place famous in the history of the early explorers and voyagers. Nicolet, Schoolcraft, Owen, Pike and other scientific explorers of the upper Mississippi in the past one or two hundred years have made this one of the noted places. Here is where they came to or left the Mississippi on their way to or from Lake Superior.

The trail from the West Savanna, a branch of the Prairie river, which at last flows into Sandy Lake, to the East Savanna, a tributary to the St. Louis river, had been used from the time tradition tells not of. A long narrow ridge in a northerly and southerly direction separates the Mississippi flood plain from that of the Sandy, and for several rods above its southerly end both rivers wash the base of the ridge. The Mississippi, where the Sandy joins it takes a bend—as in many other places noticed—and follows the course the Sandy where their waters mingle. The ridge is quite regular in out-line, about fifteen feet above the Mississippi and sixty or eighty rods long, as the north of it expands and rises perhaps fifteen feet higher; and on the southerly declivity are a number of Indian graves. The spot has probably been used as a burial place for centuries. On the ridge are many pits which were once cellars under timber houses, but now there is not a house on the ridge, and only a pit and one or two half-cut-up logs indicate where in 1864-68 Mr. Libby had his house and store.

A few granite boulders are seen on the ridge and where the Mississippi washes the base of the bluff are pebbles of granite, quartz, slatestone, etc., forming a shingle beach.

This region had long been in dispute for possession by the Sioux and Chippeways. Schoolcraft tells of sanguinary battles between them and how the fierce Chippeway warriors of the north finally drove the Sioux from this favored region and took possession: retained it until the pale-face subdued them and finally purchased of them the graves of their ancestors as well as the rich pine forests.

About two miles below the mouth of Sandy river there is a short rapid where the water breaks over large boulders and the shore is rocky.

We camped on one of the few sandy bluffs to be found between the Sandy river and Pine Bluff below Aitken.

Camp No. 20. Friday, Aug. 20.

This morning we felled an oak. *Quercus bicolor*. Willd. Pin oak, or swamp white oak, by both the common names, I have heard it called. This kind of oak is common on the flood plains of the Mississippi above Crow Wing, and flourishes as far north as Lake Winnibegosis also in the woods of Benton, MilleLacs and Morrison counties. Passed the mouth of Willow river at 3 p. m. About two miles below the mouth of Willow river by section lines, but three times that distance by the meanderings of the Mississippi, there is the worst rapids to be found between Pine Bluff below Aitken, and Grand Rapids about four miles below the Falls of Pokegama. Camped on the highest bluff to be found for many miles, in Sec. 28, T. 48, R. 26.

Camp No. 21. Saturday, Aug. 21.

Did not get started until past 8 a. m., when after a hard pull, at 12½ p. m., we entered Mud river. After dinner I went up to Aitkin station, about one mile from the Mississippi, where the Northern Pacific crosses Mud River. This is now quite a village. Made such arrangements as relieved me of the necessity of continuing the journey in the canoe to Brainerd.

Here ends one of the most instructive and interesting canoe journeys of the many that I have heretofore made in the interest of pind land owners or as U. S. Deputy Surveyor surveying public lands. In the following pages I will give a list of all the forest trees and shrubs that I have been able to identify in the region traversed. A map of the country also accompanies the paper on which I have endeavored to mark the limits where some of the most important trees form the characteristic forests.

I wish here to record my obligations to Mr. Thos. C. McClure of this city St. Cloud for his pecuniary assistance without which the journey would not have been made. Also to Mr. Geo. A. Morrison of White Earth, Mr. Wakefield of Grand Rapids, and Mr. C. H. Douglass of Aitkin, all these gentlemen having assisted to the full extent of my needs in the prosecution of the work.

The following is a list of the forest trees identified in the region traversed:

Tiliaceæ.

1. **Tilia americana**, L, Basswood, abundant........................... 14

Rutaceæ.

2.	Zanthoxylum americanum, Mill. Prickly Ash	00

Sapindaceæ.

3.	Acer dasy carpum, Ehrh, Silver maple	47
4.	Acer pennsylvanicum, L., Striped maple	50
5.	Acer rubrum, L., Red maple	51
6.	Acer saccharinum, Wang, Sugar maple	52
7.	Acer nigrum, Michx, Sugar maple	00
8.	Negundo aceroides, Torr & Gray, Box Elder	53
9.	Rhus typhina, L, Staghorn Sumach	56
10.	Rhus glabra, L, Smooth Sumach	00
11.	Rhus venenata, D. C., Poison Sumach	00

Rosaceæ.

12.	Prunus americana, Marshall, Wild Plum	76
13.	Prunus pennsylvanica, L., Wild red Cherry	80
14.	Prunus serotina, Ehrh., Wild black Cherry	81
15.	" virginiana, L., Choke Cherry	00
16.	Pyrus sambucifolia, Chem & Schlect, Mountain ash	89
17.	Cratægus coccinea, L. Scarlet fruit Thorn	94
18.	" crus-galli, L., Cock-spur Thorn	96
19.	" tomentosa, L., Pear Thorn	102
20.	Amelanchier canadensis, Torr & Gray, Juneberry	105

Cornaceæ.

21.	Cornus florida, L., Flowery Dogwood	115

Caprifoliaceæ.

22.	Sambucus glauca, Nutt, Elder	122
23.	Virbumum lentago, L., Sheepberry	123
24.	Vibumum prunifolia, L. Black Haw	194
25.	" opulus, L., Highbush Cranberry	00
26.	" nudum, L., White-rod	00
27.	" dentatum, L., Arrow-wood	00

Thymeleaceæ.

28.	Dirca palustris, L., Moose wood, leather wood	00

Oleaceæ.

29.	Fraxinus americana, L., White Ash	148

30. " sambucifolia, Lam., Black Ash........................155
31. " quadrangulata, Michx, Blue Ash........................156
32. " viridis, Michx..157

Urticaceæ.

33. Ulmus alata, Michx, Small leaved Elm(?)....................176
34. " americana, Willd, White Elm..............................177
35. " fulva, Michx, Slippery Elm...............................179
36. " racemosa, Thomas, Rock Elm...............................180
37. Celtis occidentalis, L., Hackberry.........................184

Juglandaceæ.

38. Juglans cinera, L., Butternut..............................195
39. Carya amara, Nutt. Bitternut...............................199

Cupuliferæ.

40. Quercus alba, L., White Oak................................201
41. " bicolor, Willd, Pin Oak..................................209
42. " coccinea, Wang, Scarlet Oak..............................213
43. " macrocarpa, Michx, Burr Oak..............................227
44? " palustris (?), Du. Roi. Pin Oak...........................231
45. " rubra, L., Red Oak.......................................231
46. " tinctoria, Burtram, Black Oak............................236
47. Ostrya virginica, Willd, Hop horn beam, Ironwood...........244
48. Carpinus caroliniana, Walt. Blue Beech.....................245

Betulaceæ.

49. Betula alba, L. (?) White Birch............................246
50. " lutea, Michx, f. Yellow Birch............................248
51. " papyracea, Ait, Canoe Birch..............................251
52. Alnus incana, Willd, Black Alder...........................152
53. " serrulata, Ait, Smooth Aler..............................00

Salicaceæ.

54-60. Salix, six or seven species.
61. Populus balsamifera, L., Balm of Gilead....................263
62. " canadensis, Ait..00
63. " grandidentata, Michx.....................................265
64. " monilifera, Ait..267
65. " tremuloides, Michx.......................................268

Coniferæ.

66. Juniperus virginiana, Red Cedar............................277

67.	]Chamæcyparis sphæroidea, Spach. White Cedar	283
68.	Thuja occidentalis, L., White Cedar	285
69.	Abies balsamifera, Marshall, Balsam Fir	290
70.	Picea alba, Link, White Spruce	302
71.	" nigrv, Link, black Cpruce	304
72.	Larix americana, Michx. Tamarack	307
73.	Pinus banksiana, Lamb. Black Pine	313
74.	" mitis, Michx, Hard Norway	324
75.	" resinosa Ait, Red-barked Norway	330
76.	" strobus, L., White Pine	335

The following I have heard of, as growing near Pokegama lake, but I have not seen the trees.

77.	Abies canadensis, Hemlock	299
78.	Pyrus coronaria, L. Crab Apple	87

The figures on the right of the names are the numbers in Prof. Sargent's pamphlet of the forest trees of North America.

The Forest Distribution.

In the accompanying map of the upper Msssissippi country, I have endeavored to show the region where there is a decided prevalence of one particular tree characteristic of the tract. The dotted line will very nearly represent the southern and western limits of the tract where the white pine, *Pinus strobus*, is the characteristic tree. It is from the region north and east of this line that the largest quantity of pine lumber manufactured in Minnesota at and above Minneapolis, comes. Besides this characteristic tree I have identified sixty-four species of trees, not counting the shrubs found growing in more or less abundance. in the region of country indicated. In the following table, the numbers in the first column are the numbers in the preceding list; the second column will represent the comparative abundance of the trees, taking 10, the white pine as being in the greatest abundance.

1	3	15	3	29	4	43	4	64	3
2	3	16	1	30	5	44	2	65	5
3	3	17	2	31	2	45	1	66	1
4	1	18	1	32	1	46	4	67	6
5	4	19.	1	33	1	47	4	68	5
6	3	20	8	34	3	48	2	69	8
7	2	21	2	35	1	49	2	70	3
8	2	22	4	36	1	50	4	71	3
9	8	23	3	37	4	51	6	72	6
10	3	24	2	38	3	52	7	73	6
11	2	25	4	39	1	53	3	74	3
12	3	26	2	40	6	61	4	75	3
13	5	27	1	41	1	62	8	76	10
14	3	28	2	42	3	63	4		

On the map within the region covered by the dotted line I have marked, by a line of alternate dots and dashes, a tract of land on both sides of the Mississippi, commencing a little to the east of the third guide line on the Mississippi thence in a northeasterly direction, thirty or thirty-five miles, having an average width of about twelve miles. This region is quite level and flat, so much so that the drainage is imperfect, forming extensive swamps of cedar, tamarack, spruce and balsam fir. Here the characteristic tree is the white cedar. It is from this region that the largest number of cedar telegraph poles are procured.

On the flood plain of the Mississippi where the drainage is greatest—the river having a channel in the soft spongy soil, to a depth of 6 to 14 or 16 feet, and pursuing a very torturous course—there is a thrifty growth of oaks, elms, bass, maple, ash, &c.

The plain line will very nearly approximate to the western and southern limits of the pines. There are occasionally pines seen in small groves or single trees south and west of this line, but they are exceptions. The characteristic tree between this line and the plain line, is the black pine, *Pinus banksiana*; the number of species is about the same as in the first region, but their relative abundance as well as their developement, total amounts and thriftiness of growth are different, the geology of the country is less favorable to them. The soil, except in a few limited areas, is sandy, the growth of trees, as well as of the phænogamous plants and grasses, less rank.

There are several tracts of limited extent in this belt that partake of the same geological features found in the first region, and the characteristic trees, the relative abundance and developement agree correspondingly. The largest areas of this character are found about the source of the Otter Tail River. The other and larger, south of the Crow Wing River and west of the Mississippi, includes the Little Elk River and a part of the Long Prairie River.

The following table will very nearly represent the relative distribution of trees in the second region:

1	2	11	1	21	3	31	3	41	2	51	7	68	2
2	3	12	3	22	3	32	4	42	7	52	5	69	2
3	2	13	8	23	4	33	3	43	2	53	2	70	3
4		14	2	24	2	34	3	44	7	61	6	71	3
5	3	15	3	25	3	35	2	45	1	62	4	72	6
6	2	16		26	2	36	3	46	8	63	2	73	10
7	1	17	3	27	4	37	3	47	4	64	2	74	4
8	3	18	3	28	2	38	4	48	2	65	5	75	4
9	5	19	2	29	2	39	2	49	5	66	1	76	3
10	2	20	4	30		40	3	50	3	67	2		

West and south of the plain line commences the belt of deciduous hard woods, mostly covered by dense heavy timber, with some small prairies interspersed. The western and southwestern limits of this tract I have indicated by a line of dashes separated by two dots, and it may be taken the commencement of the great prairie regions, the prairies prevailing with small groves of timber interspersed on its eastern borders.

The following is a list of the trees noted in this belt on the road east of the White Earth Agency:

1	9	10	9	19	2	28	3	37	3	46	1	62	2
2	6	11	2	20	3	29	2	38	3	47	3	63	2
3	3	12	5	21	3	30	4	39	3	48	2	64	1
4	3	13	2	22	2	31	1	40	4	49	2	65	4
5	2	14	3	23	2	32	5	41	4	50	3	..	..
6	3	15	6	24	1	33	1	42	4	51	3	..	..
7	3	16	1	25	3	34	4	43	6	52	3	..	..
8	3	17	4	26	2	35	2	44	2	53	3	..	..
9	2	18	5	27	4	36	2	45	2	61	3	..	..

SHRUBS IDENTIFED.

1. Zanthorhiza apiifolia. L'Her.

Vitaceæ.

2. Vitis cordifolia, Michx.
3. Ampelopsis quinquefolia, Michx.

Rhamnaceæ.

4. Ceanothus americanus, L.

Celastraceæ.

6. Celastrus scandens, L.

Leguminosæ.

7. Amorpha fructicosa, L.

8. " canescens, Nutt.

Rosaceæ.

9. Spiræa salicifolia.

Saxifragaceæ.

10. Ribes cynosbati, L.
11. " hirtellum, Michx.
12. " rotundifolium, Michx.
13. " prostratum, L'Her.
14. " floridum, L.
15. " rubrum, L.

Cornaceæ.

16. Cornus canadensis, L.
17. " circinata, L'Her.
18. " sericea, L.
19. " stolonifera, Michx.
20. " alternifolia, L.

Caprifoliaceæ.

21 Symphoricarpus racemosus, Michx.
22. " vulgaris, Michx.
23. Lonicera grata, Ait.
24. " parviflora, Lam.
25. Diervilla trifida, Mœnch.

Ericaceae.

26. Gaylussacia dumosa, Torr & Gray.
27. " resinosa, Torr & Gray.
28. Vaccinium oxycoccus, L.
29. " macrocarpa, Ait.
30. " pennsylvanicum, Lam.
31. Arctostaphylos uva-ursi, Spreng.

This short and imperfect list is given in the hope that another season I shall have both time and means to extend the list.

PHÆNOGAMOUS PLANTS IDENTIFIED.

Ranunculaceæ.

1. Anemone patens, L.
2. " parviflora, Michx.
3. " cylindrica, Gray.
4. " virginiana, L.
6. " pennsylvanica, L.

7. “ nemorosa, L.
8. Hepatica triloba, Chaix.
9. Ranunculus rhomboideus, Goldie.
10. “ recuurvatus. Poir.
11. “ pennsylvanicus, L.
12. “ repens, L.
13. “ acris, L.
14. Caltha palustris, L.
15. Aquilegia canadensis, L.
16. Delphinium exaltatum, Ait.
17. “ azureum, Michx.
18. Actæa spicata, L.
19. “ alba, Bigel,

Berberidaceæ.

20. Caulophyllum thalictroides, Michx.

Nymphaceæ.

21. Nymphæa, odorata, Ait.
22. Nuphar advena, Ait.

Sarraceniaceæ.

23. Sarracenia purpurea, L.

Fumariaceæ.

24. Corydalis flavula, Pursh.

Cruciferæ.

25. Nasturtium sinuatum, Nutt.
26. Arabis canadensis, L.
27. “ perfoliata, Lam.
28. “ drummondi, Gray.
29. Barbarea vulgaris, R. Br.
30. Erysinum cheiranthoides, L.
31. Lepidium intermedium, Gray.

Resedaceæ.

32. Viola rotundifola, Michx.
33. “ blanda, Willd.
34. “ selkirkii, Pursh.
35. “ cucullata, Ait.
36. “ pubescens, Ait.
37. “ tricolor, L.

Cistaceæ.

38. Helianthemum canadense, Michx.

Hypericaceæ.

39. Hypericum ellipticum, Hook.

Caryophyllaceæ,

40. Silene nivea, D C.
40. Arenaria lateriflora, L.
42. Cerastium nutans, L.
43, “ arvense, L.

Portulacaceæ.

44. Portulaca retusa, englm.

Linaceæ.

45. Linum sulcatum, Riddell.

Geraniaceæ.

46. Geranium maculatum, L.
47. “ pusillum, L.
48. Impatiens fulva, Nutt.
49. Oxalis violacea, L.
50. “ stricta.

Polygalacea.

51. Polygala sanguinea, L.
52. “ senega, L.

Leguminosae.

53. Lupinus perennis, L.
54. Trifolium repens, L.
55. Psoralea argophylla, Pursh.
56. Petalostemon violaceus, Michx.
57. “ candidus, Michx.
58. Astragalus caryocarpus, Ker.
59 “ canadensis, L.
60. “ cooperi, Gray.
61. Desmodium acuminatum, D C.
62. “ rotundifolium, D C.
63· “ cuspidatum, Torr and Gray.
64. “ paniculatum, D C.

65. Vicia americana, Muhl.
66. " caroliniana, Walt.
67. Lathyrus venosus, Muhl.
68. " ochroleucus, Hook.
69. " palustris, L.
70. Apiosa tuberosa,, Mœnch.
71. Phaseolus perennis, Walt.
72. " paucflorus, Benth.
73. Baptisia leucantha, Torr and Gray.

Rosaceae

74. Agrimonia eupatoria, L.
75. Geum strictum, Ait.
76. " rivale, L.
77. G. triflourm, Pursh.
78. Potentilla norvegica, L.
79. " arguta, Pursh.
80. " anserina, L.
81. " tridentata, Ait.
82. Fragaria virgininia Ehrhart.
83. " vesca. L.
84. Rubus, triflorus, Richardson.
85. " strigosus, Michx.
86. " occidentalis, L.
87. " villosus, Ait.
88. " canadensis, L.
89. " hispidus, L.
90. " cuneifolius.
91. Rosa lucida Ehrhart.
92. " blanda, Ait.
93. Parnassia carolina, Michx.
94. Heuchera hispida. Pursh.

Crassulaceae.

95. Penthorum sedoides, L.
96. Tillæa simplex, Nutt.

Hulorageae.

97. Hippuris, ?

Onagraceae.

98. Epilobium angustifolum.
99. Oenothera biennis, L.
100. " fruticosa, L.
101. " riparia, Nutt.
102. " pumila, L.
103. " serrulata, Null.

Lythraceae.

104. Lythrum alatum, Pursh.

Cucurbitaceæ.

105. Echinocystis lobata. Torr and Gray.

Umbelliferæ.

106. Sanicula marilandica, L.
107. Heracleum lanatum, Michx.
108. Archemora rigida. D C.
109. Conioselinum canadense, Torr and Gray.
110. Thaspium barbinode, Nutt.
111. " aureum, Nutt.
112. " trifoliatum.
113. Cicuta maculata, L.
114. Cryptatænia canadensis, D C.

Araliaceæ.

115. Aralia racemosa. L.
116. " nudicaulis, L.
117. " quinquefolia.

Rubiaceæ.

118. Galium asprellum, Michx.
119. " trifidum. L.
120. " boreale, L.
121. Mitchella repens. L.

Compositæ.

122. Liatris elegans, Willd.
123. " squarosa, Willd.
124. " cylindracea, Michx.
125. Eupatorium perpureum, L.
126. " perfoliatum, L.
127. " ageratoides, L.
128. Aster macrophyllus, L.
129. " sericeus, Vent.
129½ " patens, Ait.
130. " simplex.
131. " novæ-belgae.
132. " ptarmicoides, Torr and Gray.
133, Erigeron philadelphicum, L.
134. " strigosum, Muhl.
135. " var integrifolium. Brgel.

135½ Solidago serotina. Ait.
136. Chrysopsis villosa, Nutt.
137. Pluchea fœtida, D C.
138. Heliopsis lævis.
139. Echinacea (?)
140. Rudbeckia hirta. L.
141. Helianthus tracheliifolius, Willd.
142. " doronecoides, Lam.
143. Coreopsis palmata. Nutt.
144. Helenium antunnale, L.
145. Maruta cotula, D C.
146. Achillea millefolium, L.
147. Leucanthemum vulgare, Lam.
148. Tanacetum huronense, Nutt.
149. Artemisia canadensis, Michx.
150. " borealis Pallas.
152. Senecio lobatus Pers.
153. " aureus, L.
154. Circium, two or three species.
155. Krigia virginica, Willd.
156. Cynthia virginica, Don.

Lobeliaceae.

157. Lobelia syphilitica, L.
158. " Kalmii, L.

Campanulaceæ.

159. Campanula rotundifolia, L.
160. Campanula aparinoides Pursh.
161. Gaultheria procumbens, L.
162. Pyrola rotundifolia, L. 2 var.
163. " elliptica, Nutt.
164. " chlorantha, Swartz.
165. Chimaphilla umbellata. Nutt.

Primulaceæ

166. Lysimachia thyrsiflora, L.
167. " stricta. Ait.
168. " ciliata, L.
169. " lanceolata. Walt.
170 " longifolia. Pursh.

Scrophulariaceæ.

171. Verbascum thapsus. L.
172. Linaria vulgaris, Speng.
173. " canadensis, Mill.

174. **Scrophularia nodosa, L.**
175. **Pentstemon pubescens, Solande.**
176. “ **grandiflorus, Fraser.**
177.. **Mimulus ringens, L.**
178. “ **jamesii, Tow.**
179. **Micranthenum nuttallii, Nut.**
180. **Veronica virginica, L.**
181. **Gerardia aspera, Dougl.**
182. “ **tenuifolia Vahl.**
183. “ **setacea, Walt.**
184. **Castilleia coccinea, Spreng.**
185. “ **sessiliflora, Pursh.**
186. **Pedicularis canadensis, L.**

Verbenaceæ.

187. **Verbena hastata, L.**
188. “ **urticifolia, L.**
189. **V. bracteosa, Michx.**
190. **Phryma leptostachia, L.**

Labiatæ.

191. **Mentha canadensis, L.**
192. **Lycopus europæus, L.**
193. **Hedeoma pulegioides Pers.**
194. “ **hispida Pursh.**
195. **Monarda fistulosa, L.**
196. **Lophanthus anisatus, Benth.**
197. **Brunella vulgaris, L.**
198. **Scutellaria parvula, Milchx.**
199. “ **galericulata, L.**
200. “ **lateriflora, L.**
201. **Stachys cordata, Rid.**

Boraginaceæ.

202. **Lithospermum canescens, Lehm.**
203 “ **longiflorum, Spreng.**
204. **Cynoglossum morisoni D C.**

Polemoniaceæ.

205. **Phlox glaberrima, L.**
206. “ **pilosa, L.**

Convolvulaceæ.

207. **Ipomœa lacunosa, L.**
208. “ **pandurata, Meyer.**

Solanaceæ.

209. Physalis grandiflora, Hook.
210. " viscosa, L.

Gentianaceæ.

211. Gentiana crinita, L.
212. " detonsa Fries.
213. " quinqueflora, Lam.
214. " andrewsii Grisb.

Apocynaceae.

215. Apocynum androsæmiflolium, L.
216. " canabinum, L.

Asclepiadaceae.

217. Asclepias cornuti Decains.
218. " purpurascens, L.
219. " variegata, L.
220. " perennis, Walt.
221. " tuberosa, L.
222. Acerates longifolia, Ell.

Nyctaginaceae.

223. Oxybaphus nyctagineous Swet.

Phytolaccaceae.

224. Phytolacca decandra, L.

Chenopodiaceae.

225. Chenopodium album, L.

Polygonaceae.

226. Polygonum persicaria, L.
227. " hydropiper, L.
228. " aviculare, L.
229. " convolvulus, L.
230. " cilinode, Michx.
231. Rumex britanica, L.
232. " vertieellatus, L.
233. " acetosella. L.

Urticaceae.

234. Urtica gracilis, Ait.

235. " dioica.
236. Laportea canadensis Gaud.
237. Humulus lupulus, L.

Araceae.

238. Arisæma triphyllum.
239. Acorus calamus, L.

Typhaceae.

240. Typha latifolia.

Alismaceae.

241. Sagittaria variabilis, Englm.

Orchidaceae.

242. Cypripedium candidum, Muhl.
243. " parviflorum Salesb.
244. " spectabile Swartz.

Amaryllidaceae.

245. Hypoxys erecta, L.

Iridaceae.

246. Iris versicolor, L.
247. Sisyrinchium bermudianum, L.

Liliaceae.

248. Trillium grandiflorum Salesb.
249. " cernuum, L.
250. Zygadenus glaucus Nutt.
251. Smilacina bifolia Ker.
252. Polygonatum biflorum.
253. " giganteum.
254. Lilium philadelphicum, L.
255. " canadense, L.
256. " superbum, L.
257. Allium tricoccum, ait.
258. " schœnoprasum, L.

Juncaceae.

Three or four species.

Commelynaceae.

259. Tradescantia virginica, L.

Besides the foregoing list of phænogamous plants, I have partly identified about eighty species of others; also collected and numbered fifteen or twenty species of ferns, sixty or seventy of grasses and forty or fifty of sedges, but I am not yet prepared to affirm that the identifications can be relied upon as correct. The limited time and means at my disposal have not permitted a satisfactory study of them. One or two seasons' residence at Itaska lake, and the time wholly devoted to collecting and identifying, would hardly give a satisfactory list of all the different classes, to say nothing of the entomology and ornithology of the region.

Very respectfully,
O. E. GARRISON.

Topography.

The area comprehended in the examination is embraced between townships 130 and 147, inclusive, of ranges 25 to 40, inclusive, west of the 5th meridian, and townships 41 to 58, inclusive, of ranges 22 to 27, inclusive, west of the 4th meridian, or approximately between latitudes 46° and 47° 42 min. north, and longitude 93° 10 min. and 95° 15 min. west from Greenwich, or one hundred and twenty-six by one hundred and eight miles. In this rectangle, covering an area not far from thirteen thousand six hundred square miles, barely one thousand five hundred square miles were visited by me during the two months occupied in the explorations of the past summer, the limited time and means at my disposal not allowing of a more extended and satisfactory examination. However, excepting a strip of about 40 miles wide, on the west side, south of the line between towns 139 and 140, comprising the country of Ottertail lake and river, and that part of the west side north of the line between towns 141 and 142, about 30 miles wide, together with two small areas on the northern and eastern portions represented on the map, viz: the Bigfork river and Bowstring lake, with the three or four townships adjacent, and the Swan river region, there is but a small part of the whole area which I have not visited and taken notes on some time subsequent to the A. D. 1856, either as U. S. deputy surveyor or in exploring for pine land in the interest of lumber dealers.

The district here brought under our notice includes portions of the great drainage areas, where the chief rivers of the continent find their sources. These are the Mississippi, the Red river of the North, with a main branch of the Rainy Lake river. The first is east and south of the great water shed, whose waters flow into the Gulf of Mexico, while the other two are portions of the widely extended area whose waters are drained into Hudson's bay; while the eastern boundary very nearly follows the divide from which the waters flow east into the St. Louis river and finally into the Atlantic, through the great lakes and the Gulf of St. Lawrence.

The area of the Big fork of the Rainy Lake river is of comparatively limited extent, on the northern part of the rectangle, and near its eastern end. The Red river area is quite regular in outline, though the streams flow in widely different directions, its upper or northern portion is the broadest, its waters draining north and west, while the middle and southern portion drain to the south and west.

Of the great Mississippi area, which takes up more than three-fourths of the rectangle, the waters flow in every conceivable direction. The outline of this area may be roughly stated as a circle with an irregular or crooked circumference, having a radius of fifty miles, taking that part of the Mississippi below the mouth of Crow Wing river, thence to the mouth of the Little Elk, as a section of this radius, protract this line nearly due north, and it will cross Leech lake passing a little to the west of Lake Winnebigosis Bisect this line and from the point thus found, draw a line at right angles both east and west, extend each fifty miles, and we have the two diameters of the circle. The Mississippi river will then be comprehended in this circle with nearly all its feeders above Little Falls; while the channel of the Mississippi with a radius of about forty miles, will form nearly three-fourths of its circumference. Within this great circle are found several smaller circles within which the rivers and brooks converge to a point of outlet. Each small circle contains a *cluster of lakes*, some having a few large lakes, as that one in which is found Leech lake, and the one containing Gull, Pelican and Long lakes; the others have many small lakes. In the rectangle represented on the plate are seen seven large clusters, in all of which the water converges to one outlet, and two large and one smaller cluster from which the waters flow in opposite directions. These last will be found in Gull lake, whose waters drain south, and Pelican Lake whose waters run north, and the cluster northwest of Mille Lacs lake, where the waters drain north and northeast through Mud river and southwest by the Noaka river. The small cluster is seen to the west of the southern part of Mille Lacs, where the water drains east to that large lake and west by the Platte river. A study of this area gives the impression of one large basin enclosing many smaller ones.

The Divides.

The main divide coming on this sheet, is the one separating the waters of the Mississippi from those of the Red river of the North. Beginning at the northern limits of the State near the line of ranges 36 and 37 of the 5th mer., township 147 N., the trend is a little to the east of south to the head of upper Red lake; thence it bends to the west of south—nearly southwest, but with an irregular line, to a point to the east about two miles from the north end of Many Point lake, whence its course is nearly due south 12 or 15 miles, to near Toad lake, whence it bears off a little to the east. A high hill is visible for many miles, and the divide assumes a broad table-like expanse. From here the divide has a general south trend for twenty or twenty-five miles, and is crossed by the Northern Pacific railroad in the vicinity of New York mills; here it takes a bend to the southwest, and passes between the Leaf lakes and Otter Tail lakes where it is about eighty feet above the surface of the fourth lake of the series in the old route from the Crow Wing river by way of Leaf lakes and river. This hight of land is as mentioned by Prof. D. D. Owen in his narrative. The only place where I have had an opportunity to measure the hight of this line of divide, was where the Leech lake and White Earth road crosses near the southern part of township 141, N. R. 38, W. 5th mer., where I found it to be 1470 feet above the sea and 75 feet above the surface of the water in a small lake south of the road. Within the hills forming the divide is the outlet of the lake flowing to the west into the Otter Tail or Red river. Only small portions of the other main divides come within the limits of this sheet. That part of the northern range of hills that separates Lake Winnebigosis from Bowstring lake and Big Fork river comes within our limits near the northeast corner of town 147 N. range 27 west, 5th mer. and bears nearly southeast, passing a short distance from the Bowstring lake to near the range line between ranges 25 and 26 of town 146, N. 5th mer., where it bends to the east and the *Third guide* meridian crosses it a little north of the northwest corner in township 57, nortn 4th mer., whence it bears a little to the south of east for about six miles when the trend takes a suddden bend at nearly a right angle and leaves the limits of the map near the middle of the north boundary of town 58, N. R. 25, west of the 4th mer. This portion of the great water shed dividing the waters flowing into Hudson's bay from those flowing into the Gulf of Mexico is said to be low, seldom rising in the form of a ridge, and at the trend near the southeast end of Bowstring lake in a swamp only a foot or two above the surface of the lake. It is also said that by building a dam at a favorable place at the outlet of Bowstring lake, the waters could readily be made to flow to the south into a tributary of the Winnebigosis lake. I am not prepared to affirm this from personal inspection, but Mr. J. P. Hinchellwood, the U. S. deputy who surveyed the townships around the lake so reports. The divide on the east I have not seen, but it is reported to be high and broken, some of the hills on the trail or carry, from the head of West Savanna to the East Savanna river, by barrometer measurement, being over 139 feet above the waters of Sandy lake. In all this region there is no hill approaching to a mountain. The recorded highest point I have seen being only 1960 feet.

Subordimate divides. The area comprised within the circle where streams are all feeders to the Mississippi: may with propriety be described as a large basin within which are many small basins. Most of these subordinate basins have a drainage of their own, and are readily distinguished by the clusters of lakes seen on the maps.

Having never seen any records of the hights of these, and no opportunity to measure any of them save in a few localities having presented. I must perforce content myself by calling attention to this peculiarity in the hopes that some time hereafter an opportunity may occur to study it in the field.

The Streams.

The streams are so numerous that only a few can be noticed here.

The Mississippi. The most important of all, having its source within this district, merits a far more extended notice than I am able to give from the hasty and short time expended in its examination. It takes the name Mississippi only after its debouch from Itasca lake. There are several streams entering the lake which have disputed the right to be the extreme source. The one adopted by Nicollet and in the preceding narrative is the largest feeder to the lake and should have the name. The lake is a little over three miles long, north and south, shaped some like a letter U with a projection on the northwesterly side of the curve. The widest part is a little over half a mile. To continue the description would only be repeating what has been said in the narrative of the journey down the river.

Crow Wing River. Of the tributaries to the Mississippi, the Crow Wing is the most considerable within the limits of the district. Taking its rise in some of its branches only a few miles south of Itasca lake it pursues a general southeast course, making a southing of about sixty miles and an easting of nearly the same. Its principal feeders are the Shell, the Leaf and the Long Prairie, all of them considerable streams. Throughout its whole course and that of all of its wide spread branches, excepting those coming from the south and entering the Leaf on the Crow Wing itself, the country is of a sandy character, bearing a small growth of pines, the black pine, *Pinus banksiana* being the characteristic tree, with here and there a grove of fair sized Norway pine mixed with which is a few white pines. Yet in this area there are some large and many small tracts where the prevailing light sandy soil gives place to a rich, black sandy or gravelly loam.

Pine River is next in size and first in importance of the tributaries to the Mississippi; taking its rise south of Leech lake and east of a broad stretch of sandy plain, it has a general southeasterly course, making about 25 miles southing and 26 or 27 miles easting from its extreme branches. In nearly its whole length it appears to form the dividing line between the sandy black pine planes and the rolling or hilly country to the east and north, where the surface soil is of a heavier or clayed nature with more boulders and the characteristic tree the white pine. Its principal tributaries are the Dagget brook and the Little Pine, both important streams from which many million feet of pine saw logs are annually floated to the mills of Minneapolis and St. Cloud.

Leech Lake River is apparently larger than the Pine, but I do not think that it carries more water. The channel is deep, broad and sluggish. The general dip or inclination of the surface throughout this whole region being about southeast the course of the river is at nearly a right angle to the dip, giving to the river this sluggish character.

Willow River has its source to the southeast of Leech lake and has a general course easterly for about twenty-four miles when by a long curve it bears to the south, east, south, and then finally southwest for about 28 miles; the whole of this distance nearly parallel with the Mississippi a gradually narrowing strip lying between. In the first part of its course the country is hilly or rolling and holds some of the best pine timbered lands within the circle of which the Mississippi forms nearly two-thirds of the periphery; and from its tributaries, the Moose and Hill rivers, as many or more good saw logs have been floated to the mills than from any similar area on the upper Mississippi. Below where the bend towards the south commences the river flows through broad plains with extensive meadows and swamps of cedar; the immediate river bottoms being covered by a growth very similar to the Mississippi bottoms.

These four rivers are the principal tributaries to the Mississippi within the rectangle, and are wholly, with the exception of some of the upper parts of the smaller branches of the Crow Wing, within the circular area of which the Mississippi is the approximate periphery, and enter it from the right bank. Besides these there may be mentioned the Little Willow, and the Pokegama, tributaries direct to the Mississippi; the Shell, the Leaf, the Longprairie, Gull and Swan Rivers, tributaries to the Crow Wing; all important streams carrying much water and floating many pine saw logs each spring.

The *Little Elk*, entering the Mississippi from the right, was noted by Nicollet and Owen on account of the proximity of its mouth to some important geological features, and is an imporrant stream to lumbermen.

The tributaries to the Mississippi coming in on the left bank are generally smaller than those on the right, which is owing to the fact that the great water shed of the continent is more nearly followed in its curves by the Mississippi, as if in the great upheaving which formed the divide, a wrinkle was formed following near the summit through which the Mississippi naturally found its bed. I will mention the names of the largest beginning with the upper. Turtle, Deer, Prairie, Swan, Sandy, Rice, Mud, Rabbit and Anoka. The Platt, Rum and Snake Rivers having their source within the rectangle, are tributaries to the Mississippi, directly or indirectly.

The Red River of the North receives its principal water from within our area. Much perplexity has been occasioned by this branch as well as the Red Lake River, being indiscriminately called the Red River. Owen gives the width of the east branch, by which I suppose he means the Red Lake River, as one hundred and twenty feet and the other as one hundred feet. "The former is the stream to which the name of Red River properly belongs."* Taking its rise about twelve miles to the west of Itasca Lake, the latter has a general south course, making many detours to the east and west, passing through many lakes and receiving several tributaries in a course of about fifty miles to Rush Lake; thence it flows about southwest to Otter Tail; leaving Otter Tail Lake it has a general north of west course and leaves the district in town 134 N.

Wild Rice River has its rise in township 145 N., R. 36 W., 5th mer., and about twelve miles north of Itasca Lake, whence its course is a little south of west, seventy miles, emptying into Red River in township 144, R. 49. Having seen no part of this river, I am not able to give an account of its character or the country adjoining. A branch of the Red Lake River takes its rise in a small lake in the northwest corner of town 146, R. 39, and has a north course to the north line of our rectangle.

The *Big Fork River* rises to the north of our area and east of the fifth guide meridian, and has a southwest course to Bowstring Lake in township 147 N., R. 25 and 26 W., 5th meridian. I have heretofore at several times referred to this river, and no more information can be given. Owen's report gives a very minute account of this river and its rock exposures.*

The *East Savanna River*, a branch of the St. Louis, rises in a small lake in T. 52 N., R. 22 W., 4th mer., and is described as a stream having a width of one hundred and fifty to two hundred yards, overgrown with rushes, except a channel fifteen or twenty feet wide in the middle. The river has only eight or ten miles length within our area.

Lumbering Resources.

In the estimate of the amount of pine timber suitable for manufacturing, standing at this date, I take it that there is an equivalent to forty townships, on each forty acre tract of which there are 250,000 feet of pine standing. This is taken after a careful examination of all the data I have been able to collect, and if correct, then we shall have 5,760,000,000 feet. This includes about one township out of every nine within our district, all of which are within the area where drainage goes into the Mississippi river. It also includes the several Indian reservations, on which are many millions of feet of excellent pine, and a tract on the Big Fork river, whose waters are *now* drained into the Rainy Lake river; but it seems from the facts obtained, the two hundred and fifty or three hundred million feet on that stream, Bowstring lake and the tributaries thereto, may be floated down the Mississippi. Many of the Indians and half breeds interested in the various reservations are beginning to realize the fact that in this pine timber on the reservations they have a mine of wealth, and all will be made available to manufacturers.

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*Owen's Geological Survey of Wisconsin, Iowa and Minnesota. 1852, page 176.

How long the timber now standing and available will last is a question often asked, and it is a question of interest, not to the rising generation only, but to the present, as in a few years—at most within twenty-five—at the present rate of destruction, with no more effort than is now used to arrest useless waste or to renew the growth, will see an end of lumbering on the upper Mississippi. To demonstrate this will require only a little reflection and a few figures. There was manufactured at and above Minneapolis during the years 1875 to 1879, inclusive, 867,087,685 feet of lumber, being a mean of 173,407,737 feet per year. It is but a fair estimate that there is as much more destroyed by fires, storms, natural decay and useless waste in the forest by careless handling. On the other hand there is an increase by the annual growth of trees now too small for saw logs. From a great many measurements of the growth, I have found that a tree that in, say 1865, measured twelve inches in diameter, in 1879 measured twenty inches in diameter, an increase of eight inches in fourteen years. This may be considered as a fair average of the growth of pine in the upper Mississippi region, and an estimate of 58,000,000 as the annual increase by natural growth. Now if we add the excess of loss by causes above mentioned, amounting to 115,000,000 feet, to the annual consumption, we have a total of over 288,000,000 feet as the annual consumption and loss. Then divide the five hundred and seventy-six millions by the two hundred and eighty-eight millions and it gives an even 20 years as the time within which lumbering will cease to be a profitable business from the pineries on the upper Mississippi, unless some means are provided to prevent the annual consumption and waste.

VIII.

THE HYDROLOGY OF MINNESOTA.

A REPORT OF PROGRESS BY C. M. TERRY.

Any attempt to discuss the hydrographical system of any portion of the earth's surface should begin with the rainfall, because as has been said by a distinguished scientist, the true sources of our rivers is in the air.

The condensation of watery vapor in the atmosphere causes rain and the rain supplies our lakes and streams and springs and wells with all the water they contain.

Every drop of water even in the deepest well once floated as invisible vapor in the sunlit air and falling from thence onto the earth's surface with other drops, it percolated down through the soil, through loam, and sand, and gravel; through rock crevices and subterranean channels, until, at last the necessities of man found it in its prison, and raised once more to the light.

Every particle of water which the Mississippi bears to the sea has come from the clouds.

Every lake which mirrors the sky and reflects its light is like a child looking up into the face of its mother, for no lake could exist but for the clouds and the rain.

The average annual rainfall of a place is therefore a matter of the utmost practical importance. If it should be cut off or materially diminished the most serious consequences would ensue. Rivers would shrink to mere brooks or cease to flow, water powers would become valueless, mills would be idle, crops would fail, and the country would become an uninhabitable desert.

But the 26 inches of water which annually falls over the greater part of Minnesota makes it anything but a desert. A glance at the hydrographical map shows what a vast and complicated net-work of lakes and rivers is required to carry off even a part of this preciptation.

Few persons stop to consider or attempt to realize the vast amount of water represented by an annual rainfall of 26 inches.

It may help the imagination to obtain a more distinct conception of this fact if I quote right here a few words from a lecture by Prof. Huxley, on Rain and Dew.

"What does a meteorologist mean when he says that the annual rainfall is about 26 inches? By such a statement he means simply that if all the rain which falls on any level peice of ground during an average year could be collected, none being lost by drying up, none running off the soil, and none soaking into it, then at the end of the year it would form a layer covering the ground, to the depth of 26 inches. The year's accumulation of rain would thus form a vastness of water. Remembering that an inch of rain represents about 100 tons of water to the acre, it will be found that every acre receives during the year not less than 2,600 tons of water."

Rainfall at Minneapolis from records of Mr. Wm. Cheney showing the annual deposit of rain for ten years:

Year.	Annual Amount.	Year.	Annual Amount.
1871	30.904	1876	28.749
1872	24.946	1877	25.208
1873	31.902	1878	22.153
1874	29.043	1879	27.180
1875	30.042	1880	

The average annual rainfall for 14 years according to Mr. Cheney's observation is 29.818.

The annual rain-fall of eastern Dakota from data furnished by the war department:

Name of place.	Length of time.	Amount.
Fort Pembina	Average of 8 years	16.91 inches.
Fort Wadsworth	" " 5 "	18.95 "
Fort Abercrombie	" " 17 "	18.44 "
Fort Randall	" " 8 10-12 years	16.51 "
Fort Pierce	" " 1 10-12 years	13.51 "

The Rev. Dr. A. B. Patterson of St. Paul kept a meteorolgical record from 1860 to 1876, the year of his death.

The subjoined table gives the total rainfall for each month during a period of 16 years and also the monthly and annual means:

	Totals.	Monthly mean.		Totals.	Monthly mean.
January	15.17	0.95	September	55.79	3.46
February	17.61	1.10	October	34.63	2.15
March	23.58	1.47	November	22.08	1.31
April	31.04	2.06	December	14.38	0.90
May	56.14	3.51			
June	74.53	4.66	Total		29.08
July	46.47	2.90			
August	73.23	4.57			

The average annual rainfall is 29.08 inches.

Annual and monthly means of rainfall in Dakota from data of the War Department up to 1878.

MONTH.	Fort Abercrombie 1860 to 1877	Fort Pembina. 1871 to 1878	Totals.	Grand Mean.
January	0.52	0.18	0.70	0.35
February	0.55	0.34	0.89	0.44
March	1.01	0.70	1.71	0.85
April	1.54	1.17	2.71	1.35
May	2.16	2.65	4.81	2.40
June	3.20	3.91	7.15	3.51
July	2.23	2.81	5.04	2.52
August	2.63	2.64	5.27	2.63
September	1.66	1.24	2.90	1.45
October	0.96	1.24	2.20	1.10
November	0.64	0.52	1.01	0.50
December	0.70	0.77	1.51	0.75
Mean	18.44	16.91	35.25	17.67

Annual and monthly means of rain fall in Minnesota from data furnished by the War Department up to 1878.

MONTH.	Fort Snelling 1836 to 1878.	Fort Ripley 1849 to 1877.	Fort Ridgely 1855 to 1867.	St. Paul, 1859 to 1866. 1871 to 1878.	Grand Mean.
January	0.97	0.85	1.51	0.88	1.07
February	0.76	0.92	1.36	0.97	1.00
March	1.31	1.55	1.61	1.78	1.56
April	2.13	1.62	1.60	2.20	1.89
May	3.40	3.08	2.88	3.75	3.28
June	3.80	4.33	2.59	5.82	4.13
July	3.01	4.14	2.67	2.68	3.07
August.........	3.24	3.11	4.02	3.96	3.58
September	3.42	3.28	3.22	3.09	3.25
October	1.39	1.60	1.65	2.08	1.68
November	1.49	1.73	1.18	1.17	1.39
December	0.94	0.91	1.12	0.72	0.92
Mean	25.89	27.31	25.31	25.09 29.05	26.41

The River System.

All of the southern and central portions and a large area of the northern part of Minnesota are drained by the Mississippi river and its tributaries.

In the northwestern part of the State the Red river valley which is drained by the Red river and its affluents comprises in Minnenesota an area of over 13,176 square miles.

The drainage is toward the north. The Red River flows into Lake Winnipeg, the outlet of which is the Nelson river, which finds the ocean through Hudson's bay.

All of the most northern streams tributary to the Rainy Lake river and the system of lakes on the boundary line between the United States and Canada belong also to the Red river system and finds the ocean level at Hudson's Bay.

This portion of the State has not yet been fully surveyed and the courses of the streams as well as the size and shape of the lakes are not accurately laid down on the maps.

In the northeastern part of the State a large area estimated at about 9,000 square miles is drained by tributaries of Lake Superior. The principal river of this region is the St. Louis, which enters the Lake at Duluth.

As Lake Superior in common with other great lakes finds its outlet to the sea through the river St. Lawrence, the whole vast system of lakes and rivers affluent to the St. Lawrence have received the the name of the St. Lawrence system.

The area drained by the Mississippi and its branches comprises all the remaining portion of the State except a small tract in the southwestern corner including Rock and Pipestone countres whose streams flow into the Missouri. But as these in common with the Mississippi waters find the ocean level in the Gulf of Mexico they may be considered in the same hydrographic basin. Thus it appears that the river system in our State is threefold: 1. The Mississippi river system. 2. The St. Lawrence river system. 3. The Red river and Rainy Lake system.

Among the great rivers of the world the Mississippi takes the first rank. Its position and offices are continental as those of no other river are.

Its branches stretch from the forty-ninth parallel of latitude —the northern boundary of the United States—to the Gulf of Mexico and from the summit and crown of the Rocky Mountains, in northern Montana to the western slope of the Appalachian range in Virginia. This magnificent basin is the seat of an empire whose resources have only begun to be developed. About midway between the eastern aud western limits of this great valley are the sources of the mighty river whose arms grasp the continent. Among the clear, bright lakes of Minnesota, on the highest lands between the Arctic ocean and the Gulf of Mexico, the Mississippi begins its course.

Within the limits of our State the Mississippi grows from a rill sixten feet wide and fouteen inches deep, to a great river, half a mile wide and from 5 to 20 feet deep. It assumes within our borders its well-known character of the "Father of waters."

Let us now proceed to Lake Itasca and observe the physical aspects of the river as it appears to a voyager who descends its current from its ultimate source to the point where it passes beyond the southern boundary of our State.

When we consider the influence the Mississippi had, not only on the imagination of early explorers but also at a later date on the development of the cities and States adjacent, we cannot wonder at the enthusiasm evinced to discover and describe its utmost source and to explore the impenetrable and trackless wilderness which shrouded in its mysterious silence the origin of the great river. It was the same sort of enthusiasm which has prompted so may expeditions in search of the sources of the Nile. The discovery of the source of the Mississippi, although attended by some difficulties and hardships, was a comparatively easy task.

The first white man who is known to have visited Lake Itasca was W. Morrisson, an Indian trader and explorer. He first saw the lake in 1804.

In 1820 Mr. H. R. Schoolcraft made a memoriable expedition to the head waters of the Mississippi and proceeded as far as Cass Lake which he named for Lewis Cass then Governor of Michigan. From this point Schoolcraft turned back, but in 1832 in a second journey he pushed on to Lake Itasca and camped on the little Island in the lake which bears his name.

The next visitor who has left any public record of his expedition was Nicollet the French scientist whose name is a household word in Minnesota, since a county, a township, a lake, a railroad station, a hotel, a street in Minneapolis and an island are named for him.

Nicollet explored Lake Itasca in 1836. His description is so vigorous and charming that I transcribe a portion of it:

"The Mississippi holds its own from its very origin; for it is not necessary to suppose as has been done, that Lake Itasca may be supplied with invisible sources to justify the character of a remarkable stream which it assumes at its issue from this lake.

There are five creeks that fall into it, formed by innumerable streamlets oozing from the clay-beds at the bases of the hills that consist of an accumulation of sand gravel and clay intermixed with erratic fragments; being a more prominent portion of the great erratic deposit previously described, and which here is known by the name of "Hautes des Terres" heights of land. Now of the five creeks that empty into Itasca Lake, one empties into the east bay of the lake, the four others into the west bay. I visited the whole of them; and among the latter there is one remarkable above the others inasmuch as its course is longer, and its waters more abundant: so that in obedience to the geographical rule "that the sources of a river are those which are most distant from its mouth" this creek is truly the infant Mississippi, all others below its feeders and tributaries.

"The day on which I explored this principal creek (August 29, 1836) I judged that at its entrance into Itasca Lake its bed was 15 to 20 feet wide and the depth of water from 2 to 3 feet. We stemmed its pretty brisk current during ten or twenty minutes, but the obstructions occasioned by the fall of trees compelled us to abandon the canoe and seek its springs on foot along the hills. After a walk of three miles during which we took care not to lose sight of the Mississippi my guides informed me that it was better to descend into the trough of the valley; when, accordingly, we found numberless streamlets oozing from the basis of the hills The temperature obtained at a great number of places by the thermometer in the mud whence these springs arose, was always between 43° 5 min. and 44° 2 min. Fah., that of the air being between 63° and 70 .

Having taken great pains in determining the temperature, I have a right to believe that it represents pretty accurately the mean annual temperatures of the country under examination.

As a further description of these head-waters I may add that they unite at a small distance from the hills whence they originate and form a small lake from which the Mississippi flows with a breadth of a foot and a half and a depth of one foot. At no great distance, however, this outlet uniting itself with other streamlets coming from other directions supplies a second minor lake, the waters of which have already acquired a temperature of 48° Fah. From this lake issues a rivulet necessarily increases importance—a cradles Hercules giving promise of the strength of his maturity, for its velocity has increased; it transport the smaller branches of trees; it begins to form sand-bars; its bends are more decided until it subsides again into the basin of a third lake somewhat larger than the two preceding. Having here acquired renewed vigor and tried its consequence upon an additional length of two or three miles it finally empties into Itasca Lake, which is the principal reservoir of all the sources to which it owes all its subsequent majesty."

Lake Itasca.

The lake which is the acknowledged source of the Mississippi river, is in no way remarkble. Not unlike some historical movements, whose beginnings are obscure, this river which becomes a marked feature of the continent, has a humble origin.

Itasca lake lies on the northeast corner of T. 143, N. range 36, W. 5th meridian.

It is quite small. Its total length does not exceed five miles. It is from a quarter to half a mile wide. The lake consists of two arms of unequal length uniting in a third arm which, however, is no larger or longer than the others. The longest arm extends to the southeast about two and a half miles. The shorter arm extends to the southwest and is about a mile long. The third arm extends north from the point where the two arms already mentioned unite, and is about two miles long.

The inlets of the lake are on the shorter or southwest arm. There are five of them. They are small streams draining the swamps and springs in the vicinity. Less than a quarter of a mile south of the southwest arm is a little lake called Elk lake. It has an area of about 200 acres. It is a mile long and half a mile wide. It is a tributary of Itasca lake through a small creek which connects them. Elk lake has two or three small streams flowing into it from the south. The principal stream tributary to Itasca lake directly, also flows from the south and is three or four miles in length. It is rather a refinement of exactness to call Elk lake, as some explorers have, the ultimate source of the Mississippi. Itasca lake has been in possession of the honor so long, that its claim ought not to be disputed, and certainly it is sufficiently minute, remote and sylvan to answer all the requirements of an ideal "source." The area of Itasca lake is about 1125 acres, or not quite two square miles of water. Its depth varies from ten to twenty-five feet.

The temperature of the water in August was 62° Fah., at the same time the air was 56° Fah. In July Mr. Siegfried found water 74° Fah., air 76 F. There are probably no springs in the lake itself. The water, however, is clear and wholesome. A dense forest of mixed hardwood and pine trees surrounds the lake. The immediate shores are not high, although back a short distance the sand ridges and hills rise in some places 120 feet from the lake. Issuing from Lake Itasca in a stream 14 inches deep and 16 feet wide, the infant Mississippi flows nearly due north for twenty or twenty-five miles. Its banks are low, and for some distance on either side adjacent lands are swamps. Fallen trees and floodwood at first somewhat obstruct the channel. There are several small tributaries in the first fifty miles, and the river gradually becomes broader and deeper.

About twenty-five miles (fourteen miles in a straight line) north of Lake Itasca, the river makes a bend to the east and continues to flow in a general easterly course as far as the outlet of Lake Winnebigosis, a distance of fifty-four miles in a straight line and nearly twice as far by water.

Lake Pemidji or "Lac Travers."

Just before entering Lake Pemidji the river passes through a small lake, the first on its course, named Lake Marquette. Pemidji, or "Lac Travers" of the early fur traders, is a beautiful large sheet of water about seven miles long by two or three miles wide. Its waters are clear and pure. It has no islands. Its depths range from 12 to 40 feet.

On issuing from Lake Pemidji the river is 150 feet wide and it continues to maintain a breadth of 110 to 150 feet till it reaches Lake Cass. Its depth varies from two to six fee. For the first 15 or 20 miles below Lake Pemidji the river flows over numerous granitic boulders causing rapids. The current is quite swift and strong.

Cass Lake.

The river enters Cass Lake on the west side about midway between its northern and southern limits. The lake is a large one and has many bays and islands. It covers an area of about 31 6-10 square miles. It is longest from north to south. Including Pike Bay its length is not less than twelve miles.

The surrounding country is a forest of elm, maple and pine.

This was the furthest point reached by Mr. Schoolcraft in the expedition of 1810. The lake was then named Lake "Cassina" and it was regarded for a time as the source of the Mississippi.

The river where it leaves Cass Lake in township 146, range 30, has a width of 172 feet and is 8 feet deep. Its banks are 10 to 12 feet high. Between Cass Lake and Lake Winnebigoshish the river has a narrow flood plain. A short distance back from the water there is a bench of higher land supporting a fine growth of pines. The distance between these two lakes in a direct line is only ten miles. Following the course of the river it is about 20 miles. The most attractive country near the head waters of the Mississippi is between and around these lakes.

Lake Winnebigoshish.

This lake—the second in size in this region—has an area of seventy-eight and a half square miles. It is eight miles wide by about twelve miles long from north to south. The river enters on the southwestern side and leaves it at the northeast corner.

Unlike most of the lakes in this part of the State, the waters of Winnebigoshish are not clear and translucent. The Indian name, it is said, signifies "turbid water". For some distance out from the shores the lake is very shallow and this fact taken in connection with the clay bottom accounts for the yellowish white aspect of the water. The stiff blue clay called "till" underlies, at the depth of a few feet, the sand and other superficial deposits which cover the surface of the country. Aside from the Mississippi it has three inlets called Turtle river, Round Lake river and Thornberry river. By natives and traders in the vicinity, this lake is called Winnepeg. On leaving Lake Winnebigoshish the river bends to the southwest. After passing through a small lake called Little Winnebigoshish the river is very tortuous; the banks are low and marshy. The distance from Lake Winnebigoshish to Pokegama Falls is about 65 miles. About 20 miles below the lake the Leech Lake river enters from the west. The river continues to wind through a vast marsh where there is a dense growth of grass, reeds and wild rice. This marsh is about three miles wide beyond which are sandy ridges with a sparing growth of pines. The current of the river is sluggish. The fall from Winnebigoshish to Pokegama falls is but 23 feet. This whole country above Pokegama falls is a great watery plateau, lakes abound in every direction. The difference in level is very slight. Immense swamps adjoin these lakes and retain the rainfall so that sudden rise and fall in the lakes and streams is impossible.

Leech Lake and Leech Lake River.

The principal tributary to the Mississippi above Pokegama falls is the Leech Lake river, which is the outlet of Leech Lake. It is 35 miles long. It is situated in the northern part of Cass county. Its northern limit is only five or six miles south of Lake Winnebigoshish. It drains a large extent of country; four large streams and eight smaller ones flow into it; the water is pure and wholesome; its greatest depths are in the southwest bay, varying from 50 to 100 feet. The bays generally are shallow, varying from 6 to 10 feet in depth. The main body of the lake is from 10 to 13 feet deep. The extreme range between high and low water is 1.7 feet.

The western and southern shores are high and bold. On the northern side there are more marshes and the shores are lower. Evidences of a former higher stage of water are abundant. The old shore line incloses marshes which, owing to the growth and decay of wild rice, rushes and other acquatic plants are constantly encroaching on the lake and diminishing the area of water. Along the bold shores, and all points where the action of ice and waves has not been impeded, there are walls of bowlders, These are mainly crystallized rocks, either granite or gneiss.

Forest Trees.

The forest about Leech lake consists chiefly of pine. The species *Pinus strobus*, white pine, and *P. resinosa*, Red or Norway pine, predominate. The balsam fir, *Abies balsamea*, the tamarack *Larix Americana*, the white cedar, *Thuja occidentalis*, occupy the swamp and low lands. The birch, poplar and maple among deciduous trees are found in places on the uplands among the pines.

Leech lake has three or four islands. The largest is Bear island and is about three miles long. There is a great variety of shore. There are deep bays, and long wooded points, producing a picturesque intermingling of land and water. (Leech lake might be raised two feet without injury to any adjacent shore.)

Pokegama Falls.

From the mouth of Leech Lake river to Pokegama Falls, a distance of 45 miles, the Mississippi continues to wind through a great morass. The current is slow, owing to the tortuous course of the river and the very slight slope: the fall is only 13⅔ feet in the 45 miles. At Pokegama Falls the river plunges over the first exposure of 'rock seen in descending its course. It is a quartzyte or metamorphic sandstone formation bearing N. E. and S. W. There is no perpendicular fall of the river here, but through a narrow chute the river rushes with great velocity, falling 14 feet in a distance of 880 feet. The altitude of Pokegama falls—head of falls—above the sea is 1266.71 feet.

The exposure of quartzyte seen at Pokegama falls is more finely displayed on the Prairie river, a tributary which enters the Mississippi from the east, two or three miles below the falls.

Below Pokegama falls are the Grand Rapids. There is no rock in place here, but the channel is obstructed by bowlders, over which the water rushes, falling five feet in a distance of 1750 feet. Grand Rapids is the head of navigation on the upper Mississippi.

A notable change in the aspect of the river and the adjacent country occurs below the falls. Some outlines of a valley appear; there are bottom lands covered with elm, ash, birch, basswood and spruce trees, while beyond are higher ridges and levels on which the pine finds a congenial habitat.

The banks of the river are generally higher than above the falls, and the slope averages six inches to the mile as far down as the mouth of the Mud river, near Aitken, on N. P. R. R. The river is very crooked, but its general direction below the falls is first southeast, then south and southwest to Aitken. It is 150 miles by river from the falls to Aitken. The area of the water-shed of the river in this distance is 2,500 sq. miles.

The principal tributaries between Pokegama falls and Aitken are:

On the east bank, in descending order: Prairie, Wild Swan, Sandy Lake, Rice and Mud rivers.

On the west side are: Split-Hand? and Willow.

A brief notice of these rivers is all that can be allowed in this chapter.

Prairie River.

The Prairie river has its sources in the innumerable small lakes and marshes north of Pokegama Falls. It has a swift, strong current, and in time of high water brings down a large volume to swell the Mississippi, which it enters about three miles below Pokegama falls.

The Wild Swan River.

The Swan river rises in Swan Lake or rather in the tributaries of that lake, and flowing in a southerly direction parallel with the Mississippi for 25 or 30 miles, finally bends to the west near its mouth and enters the Mississippi about midway between Grand Rapids and the outlet of Sandy lake, in Tp. 52, R. 13.

Sandy Lake River.

Sandy Lake river is the outlet of Sandy lake, 86 miles below Grand rapids. The lake has several important affluents. The Sandy river flows into the lake from the south. The N. P. R. R. passes on its head-waters between Kimberly and Island lake stations. In the early history of the northwest this lake had considerable celebrity as a trading post.

Rice River.

Rice river rises in Rice Lake, and the watershed east of Mille-Lac which divides the waters flowing into St. Crois from those of the Mississippi. It enters the river north of Aitken.

Mud River.

The Mud River has its head-waters in the region near the northern end of Mille Lac. Its general course is north.

Willow River.

Willow River is the largest of these affluents. Its sources are southwest of Pokegama Falls. It drains a large territory covered with a dense growth of pines. Its general course is south and parallel with the Mississippi which it enters about 125 miles below Grand Rapids.

In connection with this description of the physical features of the upper Mississippi, some account of the proposed "reservoir system" seems appropriate.

According to the "Report of the Chief of Engineers" for 1879 it is proposed to construct drains for the purpose of restraining and storing the waters of the Mississippi at the following named points: outlet of Lake Winnebigoshish; outlet of Leech Lake; Mississippi river below Vermillion river; Mississippi river at the head of Pokegama Falls.

In addition to these dams are proposed on Pine river and at Gull Lake. In estimating the effect of the reservoirs on the river the last two are not taken into account.

The area and storage capacity of the four reservoirs above Pokegama Falls is stated as follows:

1. The dam at the outlet of Lake Winnebigoshish is to be 14 feet high and 1,114 feet long. This would pond the water up through the Mississippi river into Cass Lake.

Reservoir capacity, 45,754,204,380 cu. ft.

Area of reservoir surface, 4, 312,701,360 sq. ft.

Aree of the basin of supply, 527,459,328,800 sq. ft.

2, The dam at the outlet of Leech Lake is to be 4 feet high and 3,300 feet long.

Reservoir capacity, 22,567,564,800 cu. ft.

Area of reservoir surface, 6,091,430,400 sq. ft.

Area of basin of supply, 27.906,278,400 sq. ft.

3. The dam on Leech Lake River below Mud Lake is to be 6 feet high and 1000 feet long,

Reservoir capacity, 2,885,414,400 cu. ft.

Area of reservoir surface, 480,902,400 sq. ft,

Area of basin of supply, 4,460,544,000 sq. ft.

4. The dam on the Mississippi river below the mouth of the Vermillion river is to be 10 feet high and 2,300 feet long.

Reservoir capacity, 5,770,823,800 cu. ft.

Area of reservoir surface, 961,804,800 sq. ft.

Area of supply basin, 12,071,346,800 sq. ft.

5. The dam at Pokegama Falls is to be 7 feet high and 400 feet long.

The total available supply of water from these five reservoirs is computed in round numbers to be 70,000,000,000 cubic feet. This would furnish for a period of 120 days, between the first of July and the first of November, a supply of 6,750 cubic feet per second, in the river below the falls. The low water flow at St. Paul, where a continuous record of gauge-readings has been kept since 1872, is 5,800 cubic feet per second. In October 1878 the measured discharge at St. Paul was 6,150 cubic feet per second. Adding the reservoir supply to the low water discharge, we get as a result a steady flow of 12 to 13,000 cubic feet per second, past St. Paul during the low water season between July and November.

It is proposed to shut off the entire Mississippi between December first and July first and store the low water discharge as well as rainfall during that period. It is believed that early spring navigation between Aitken and Grand Rapids would not be injuriously affected by this retention of the water above Pokegama Falls, inasmuch as the area of the Mississippi basin between Pokegama and Aitken is 2,500 square miles, and there are several important affluents, already described in this distance. It is thought therefore that previous to July first the Mississippi below Pokegama will have sufficient water for navigation without the flow that naturally comes over the falls.

The data for computing the amount of surplus water in the reservoirs on the first of July, may require modification. It is assumed that the mean annual rainfall for the upper Mississippi basin is 25 inches and that about one-third of this, or 0.7 ft., finds its way into the streams and rivers. The amount lost by evaporation is at present unknown. The amount which will be absorbed by the overflowed lands can only be determined by experiment.

Notwithstanding these and other obscure and doubtful elements in the problem, it appears reasonable that a sufficient amount of water can be stored to give the Mississippi at St. Paul a steady flow during the dry season of 10 to 13,000 cubic feet per second. This would be a great gain both to commerce and manufactures in our state.

Pine River.

The only other important affluent of the Mississippi above Brainerd is the Pine river which forms the outlet of a chain of lakes of which Whitefish and Cross lakes are the largest. Pine river drains an area of about 600 sq. miles. Its general direction is east and south: it enters the river about midway between Aitken and Brainerd. The general course of the Mississippi between these points is west. The pine river, therefore, enters from the north. It is a rapid stream. Its measured low water volume was 782 cu. ft. per second.

In this stretch of the river there three notable rapids.

1. Big Eddy Rapids, where the fall is 5.15 ft. per mile for half a mile.

2. Island Rapids, which are 3000 feet long and the slope 4.62 ft. per mile for the first 800 feet.

3. French Rapids, about 400 feet long and the slope averages about 6 ft. per mile.

Some conception of the volume of the river in this upper rigion may be derived from noting the discharge in cubic feet per second at various points of observation on the river. The following table is from report of chief of engineers U. S. A., 1879.

DISCHARGE OF THE MISSISSIPPI RIVER.

DATE.	STATION.	Height above low water.	Discharge in cubic feet per second.
1874.			
Sept. 8	Above Cass Lake	Mean H. W.	517
Aug. 22	Below Cass Lake	1.855	891
Sept. 26	Below junction of Leach Lake River	3.931	1,958
Oct. 12	Above Pokegama Falls	2.569	2,474
Oct. 15	Below Grand Rapids	Mean H. W.	2,525
Oct. 20	Below Swan River	Mean H. W.	2,969
Oct. 27	Below Sand Lake Riʌer	Mean H. W.	2,946
Nov. 3	Below Willow River	Mean H. W.	3,784
1878.			
Oct. 14	Below Lake Winnebigoshish	Mean L. W.	541
Oct. 21	Below junction Leach Lake River	Mean L. W,	909
1875.			
May 26	Brainerd	8.50	13,084
May 31	Brainerd	8.46	13,082
June 3	Brainerd	9.05	13,444
1875.			
May 13	Sauk Rapids	6.36	22,084
May 15	Sauk Rapids	6.24	22,700
May 20	Sauk Rapids	6.17	21,199
June 7	Sauk Rapids	8.00	30,936
June 15	Sauk Rapids	6.50	34,668
Jusy 16	Sauk Rapids	2.38	8,336
July 19	Sauk Rapids	2.15	7,537

The Minnesota River.

A small stream about twenty feet wide and from one to two feet deep, enters Brown's Valley one mile below Lake Traverse from the northwest, and after making several bends, empties its waters into Big Stone Lake. This stream is the Minnesota river at its beginning. It drains the uplands that stretch away to the conteau northwestward from Big Stone Lake. It has several affluents, and drains an area of 310 square miles.

Brown's Valley is about five miles long, and from one two miles wide. The valley is nearly level and is elevated, in general, from 15 to 20 feet above the lakes on either side. Its soil, gravel-ridges and sloughs give evidence that it was once the bed of a great river. At present it is dry, except times of very high water, when the infant Minnesota overflows its banks, and the lakes are raised to the highwater level. In these circumstances the sloughs and marshes are filled, and there is a water connection through them between Lac Travers and Big Stone.

This connection is, however, only temporary and incidental. The outlet of Lac Traverse is through the Bois de Sioux into the Red River of the North. The elevation above the sea is 1000 feet, while that of Big Stone is 992, making a difference of 8 feet. But the filling up of Brown's Valley with alluvium and silt of the old river has constituted here a "divide" or water-parting, so that Lac Travers has become a part of the Hudson's Bay system, while Big Stone remains loyal to the Mississippi.

Big Stone Lake (Inyan Tonka) is so named on account of the exposure of granite about one and a half miles below the outlet of the lake, where the rock outcrops in large round and glaciated masses, which rise, in some instances, from 40 to 60 feet above the river. The lake is about 26 miles long, and from a mile to a mile and a half wide. Its greatest depth is abovt 30 feet. Its basin is the trough excavated by a glacial river which formerly drained the Red River valley. Gen. Warren and others have suggested that the silting up of the valley just below the lake, at the mouth of the Whetstone, by the sediment brought down by that tributary may account for the existence of Big Stone Lake.

The bluffs which enclose the whole valley on both sides are here from 125 to 150 feet high. The descent is gradual at some points, abrupt at others; or they rise from the lake shore almost perpendicular to it, for 40 or 50 feet, and then slope away to the summit. The shores are wooded, and walled with boulders. There are several small streams entering the lake through deep ravines. At the lower end are several wooded islands; the largest (Chamberline's) contains about 125 acres. Another, called "Paradise Island" contains about 70 acres. Ortonville and Big Stone City are situated at the foot of the lake. At the outlet of the lake, the Minnesota is about 20 feet wide and flows through a marsh which extends between the bluffs for a distance of two miles.

The general course of the river is southeast, until at Mankato it bends to the northeast and continues in that course till it reaches its junction with the Mississippi at Fort Snelling. The first tributary to the Minnesota below the lake is the Whetstone (Izuzu) which enters the valley through a deep ravine on the west or right-hand side. It has its sources near the Dakota Coteau and is about 25 feet wide at its mouth. In low water its depth is 2 to 3 feet rising, in freshets, to 8 and 10 feet. Its area of watershed is 110 sq. mi. Below the Whetstone the valley is about a mile and a half wide while the river is less than 50 feet wide. Ledges of granite and granite boulders are numerous in the hollow lands.

The Yellow Earth River (Mankareoza)

is sometimes called the Yellow Bank. The Indians also called it *Chra Wakon* spirit mound on account of a hill near its source. At its confluence with the Minnesota it is about 25 feet wide. It has its source near the coteau and its course is among gravelly hills and ridged in the western townships of Lac qui Parle county. Its waters comprises about 340 square miles.

Proceeding down the river some three or four miles below the Yellow Earth, we come to a broad marsh about one mile wide and four miles long. The valley of the Minnesota at this point is 3½ miles wide. whilethe river is from 50 to 60 feet wide.

The Pomme de Terre (Tipsina)

river has its sources in Turtle Lakes, Wall lakes and Eagle lake in Otter Tail county.

Its course is almost directly south and it drains an area of about 1000 square miles. It enters the Minnesota valley on the left through a deep ravine, and has brought into it a vast amount of sediment, which has probably caused the existence of the marshy lake before described, above its mouth. At its confluence with the Minnesota the Pomme de Terre is 35 feet wide. At this point twenty miles below the outlet of the lake the Minnesota has a volume of 42 cubic feet per second in low water.

Lac qui Parle, or the Lake that Talks.

The name is said to be a translation of a Dakota word, signifying echoes. Others hold that the name was given by French traders on account of the resounding of waves on a rocky point of the shore.

The lake is an expansion of the Minnesota River, caused by the barrier of sand and silt which has been brought into the valley by the Lac qui Parle River. It is eight miles long. Its width varies from one-half to three-fourths of a mile. Its greatest depth is about 12 feet. At the upper end of the lake are extensive marshes and there is considerable low, wet land about the lake, which is flooded in seasons of high water. Granite exposures occur on the south side and near the foot of the lake there is a low outcrop on both sides which is submerged except during the dry season.

Lac qui Parle (Intpah) River.

It is said that the Indians gave this river the name *Cha Intpah*, signifying the last wooded stream. It is the last in ascending the river which had timber on its banks in any considerable amount. The river enters the Minnesota Valley on the right bank just below the foot of the lake.

The *Lac qui Parle River* is an important affluent. It drains an area of 830 square miles in Lac qui Parle and the western part of Yellow Medicine counties. Its sources are among the hills and ridges on the western boundary of the State in Canby and Lincoln counties.

Its general course is north and northeast. Its valley varies from an eighth to a fourth of a mile wide, and it has a fall of six to eight feet per mile. In the season of high water it pours a large quantity of gravel and silt into the Minnesota which has probably occasioned the existence of the lake by filling up the valley and thus causing a barrier opposite the mouth of the Lac qui Parle River. The valley of the Minnesota is only one and a half miles wide, and there is an island dividing the ancient channel. The Minnesota flows through the right channel; the Chippewa comes into the left channel and joins the Minnesota at the foot of the island 12 miles below the lake.

The Chippewa River

has its headwaters in the small lakes in the northern part of Douglas county. The sources of the Chippewa are 80 miles in a direct line from its mouth. It drains an area of 2,000 square miles, comprising some of the most fertile and productive lands in the state. Its watershed includes the western part of Douglas, all of Pope and a large share of Swift and Chippewa counties.

Two branches unite near Benson to form the main river. The west branch is the larger and has its source in the north part of Douglas county. The east branch has its sources in the eastern part of Pope county. The country drained by these branches is rolling and hilly. It is the morainic deposit described elsewhere. The river descends more than 400 feet from its source to its confluence with the Minnesota. In the western part of Douglas county, St. P., M. & M. R. R. crossing, the elevation of the river is 1339 feet above the sea. At Benson the elevation is 1021 feet. At its junction with the Minnesota 939 feet, showing a fall of 400 feet.

The valley of the Chippewa, like that of the Minnesota, appears to have been the course along which a glacial river, issuing from the retreating ice-fields, poured its floods of water. The valley is often from a fourth of a mile to a mile wide, and could not have been eroded by the river as it now is.

Ten miles below the Chippewa the Minnesota valley become much narrower. The river itself is about 100 feet wide and there are numerous outcrops of granite, a succession of reefs over which the water flows with rapid current. This is one of the most interesting points in .the valley. The granite masses rise from 30 to 75 feet in height and are a picturesque relief to the eye. The head of the rapids is in T. 116, R. 30, sec. 20. The distance from this point to the foot of Minnesota Falls is 5.38 miles and the total fall in the distance is 49.78 feet. Here are located the thriving towns of Granite Falls and Minnesota Falls with their valuable water-powers. The river makes several sharp bends within the valley, but the general southeast course remains unaltered.

The Yellow Medicine

Enters the Minnesota 20 miles below the Chippewa. Its sources are among the hills and basins of Lincoln county. It drains parts of Lincoln, Lyon and Yellow Medicine, an area altogether of 650 square miles. Its general course is north of east.

At the junction of the Yellow Medicine and Minnesota on the bluffs overlooking the valley, was located the upper Sioux agency, famous in the earlier history of the state, and the scene of a terrible tragedy in the Indian outbreak in 1862.

The volume of water in this river is variable. The high water marks indicate that it rises 10 or 12 feet above its low water level.

Hawk Creek (Chetomba).

Half a mile below the mouth of the Yellow Medicine Hawk Creek enters the Minnesota from the north. Its sources are in the southwestern part of Kandiyohi and it drains also parts of Chippewa and Renville counties, an area of about 470 square miles. It has eroded a deep channel through the bluffs.

From the foot of Minnesota falls to the mouth of the Yellow Medicine river. the distance is about 4½ miles. and to the mouth of the Redwood it is 25 miles. There are two sets of rapids where ledges of gneiss occur. The first is called Patterson's rapids, and four miles below these are Brown's rapids. The average slope of the river along this part of its course is a little over 2 feet to the mile. Several small streams from the river below Hawk creek, Rice creek, Boiling Springs creek and Sacred Heart creek. The high water mark of the Minnesota above the Redwood is 24 feet above the low water level. The measured discharge of the river in low water, was 217 cu. ft., per second.

The Redwood River.

The Redwood has its sources in the western part of Lyon county, in the same hilly region from which the Cottonwood and Yellow Medicine descend. Its general course is east, and parallel with the rivers first named. It drains an area of 770 square miles, lying in Lyon and Redwood counties.

The gorge at Redwood Falls is two miles long. The river has worn its way down into the granite, and falls a hundred feet in half a mile. The total fall from the top of Cook's milldam to the Minnesota river is 125 feet. The water powers here are valuable, and the place is unsurpassed by anything in the State for its wild and picturesque beauty.

Beaver Creek

Enters the Minnesota three miles below the Redwood, from the north. It is 30 feet wide at its mouth. It drains an area of 240 square miles in Renville county. From the Redwood to the Big Cottonwood the distance is about 40 miles, and the fall of the river 35.75 feet.

The river averages 150 feet in width, while the valley varies from a mile to a mile and a half wide. The low water discharge of the river at Ft. Ridgely which is situated about half way between the affluents above named, was found to be 253 cubic feet per second, and just above the Cottonwood, 307 cu. ft. per second. As the granites and gneisses of this valley are described and classified in another chapter, no attempt is made to recount their appearance, and characteristics here, although they constantly form a very striking and picturesque feature of the scenery. The last exposures of these rocks seen in descending the river, is about four miles below Ft. Ridgley.

The Cottonwood River. (Waraju)

Its numerous sources are chiefly in Lyon county. Its general course is east. It drains an area of 980 square miles in Lyon, Redwood, Brown and Cottonwood counties. Its confluence with the Minnesota is three mile below New Ulm, where it is 120 feet wide. The volume of water varies with the season. In times of freshet it rises 10 feet or more above low-water, and pours a rapid flood into the main river.

The Blue Earth River,

is the largest tributary to the Minnesota. It has many branches; some of them nearly or quite as large as the main stream. There is here a remarkable confluence of several rivers flowing from the west, south and east, to a common center where they combine and discarge their united volume into the Minnesota. The drainage basin of this system comprises Watonwan, Martin, Blue Earth, Fairbault and Waseca counties. The total area of the watershed is 3350 square miles.

The stream which bears the name of the Blue Earth rises near the Iowa boundary line. and its general course is nearly north.

Its principal affluents on the west bank named in descending order, are the West Fork of the Blue Earth, Badger Creek, South Creek, Centre Creek, Elm or Chain Creek, and the Watonwan River. These drain Martin and Watonwan counties. The tributaries of the Blue Earth on the east bank named in descending order, are Coon creek, East Fork and Le Sueur river. Of these the most important is the Le Sueur, which joins the Blue Earth three miles above its mouth, and and at their confluence is the largest stream.

The Le Sueur has its source in the southern part of Waseca county. Its course is north, then west. It makes a rather large bend in Blue Earth county, and is joined first by the Cobb river then by the Maple river, at a point about six miles south of Mankato.

The Cobb and Maple rivers have their sources in the northern part of Faribault, and flow nearly parallel, in a northerly course, till they join the Le Sueur.

At the mouth of the Blue Earth the Minnesota bends to the north, and takes a general northeast course to its junction with the Mississippi. The cause of this deflection of its course is explained by the geological formations here, as set forth in another chapter. Below Mankato the Minnesota has few important tributaries. Its drainage area is now much more limited.

The principal affluents, in their order descending the river, are the following: The Shanaska, a small stream entering the Minnesota, from the east, at Kasota, in Le Sueur county. It is the outlet of Lake Washington. It has two water powers.

Cherry Creek enters the Minnesota from the east at Ottawa. It rises in the small lakes in Cleveland and drains an area of about 60 square miles.

Little LeSueur creek drains the northern part of LeSueur county, an area of 114 square miles and finds the river at LeSueur. It has two small water powers.

Rush river drains the northeast part of Sibley county, an area of 102 square miles and enters the river from the west.

High Island Creek has its source at High Island Lake or Auburn Lake. It drains an area of 75 square miles in northeastern part of Sibley county and joins the Minnesota from the west.

Sand Creek drains an area of 234 square miles in Scott county and enters the Minnesota from the east near the Little Rapids above Chaska. It has three water powers. Carver Creek drains

160 square miles in Carver county. Its sources are the lakes of Waconia. There are two small water powers.

Credit river flows north and joins the Minnesota. It drains 140 square miles in the eastern part of Scott county. It has one water power at Hamilton where it unites with the Minnesota.

Nine Mile creek drains 42 square miles of Hennepin county and finds the Minnesota from the west, being the last affluent.

The Red River of the North and its Tributaries Above its Junction With the Bois de Sioux at Breckenridge.

This is considered by some authorities as a distinct river and is called the Otter Tail river. In various reports of the War Department by engineers and others, the Red River is said to have its source in Lake Traverse and the Otter Tail river is regarded as a tributary. Dr. Owen, in his geological report of Wisconsin, Iowa, and Minnesota makes Otter Tail lake the source of thee Red River. H makes no mention whatever of the section of the river above OtterTail lake, and remarks of the Red River which he descended from Otter Tail lake to Pembina that it was called by the Indians "The Otter Tail."

The ultimate sources of this stream are not more than ten or twelve miles west of the headwaters of the Mississippi in T. 143, R. 38. There is in this part of the State a rolling, undulating tract, generally elevated between 1,500 and 1,600 feet above the sea. The hills and ridges rise variously from 25 to 100 feet above the intervening lakes. There are numerous swamps and marshes and lakelets, and the whole region is nearly forest-covered. Here, within a radius of a dozen miles, the Mississippi river, the Red river, the Wild Rice river, the Shell river and the Buffalo river have their sources.

There is a small, nameless lake about six miles north of Elbow Lake, where the river has its ultimate source. The stream flows south and passes through Elbow lake, Many-point lake and Round lake in the order named. Its course then trends southwest; it passes through Height of Land lake and continues in the same general direction some 15 or 18 miles further till it is crossed by the N. P. R. R. at Frazee. The course of the river is thence southeast as far as Pine lake, and thence south to Otter Tail lake. The elevation of the river bed above the sea near Perham is 1,327 feet. The elevation of Otter Tail lake is 1,325 feet.

Thus far the river has no clearly marked valley. It flows in a channel eroded by its own agency in the drift. The banks vary from 6 to 20 feet high. Sometimes there are swamp-like expansions at one side or the other of the stream. At other points the banks are perpendicular or abrupt and the river has eroded the side of a bluff. But in general the characteristics of the river are those simply of a drainage channel, carrying off the surplus waters of the region. It is commonly termed the Otter Tail creek above the lake. Below Otter Tail lake the Red river assumes a somewhat different character. Having received in the lake itself two important affluents, it flows out at the southern extremity a swift, strong current between moderately high bluffs.

The country through which the river winds is exceedingly hilly and rough. The morainic deposits are composed of clay, sand and gravel, and the river eroding the sides of these hills and bluffs, becomes colored by the earthy matter held in suspension, so that it is milky or whitish-yellow in appearance. It passes through three or four lakes which are little more than expansions of the river where the conformation of the surface favored the spreading out of the water. Owen finds ten of these lakes, but some of them must have disappeared, for at present there are only three or four places that can claim that distinction. The descent is quite appreciable and the current generally rapid. In fairly high water the river rushes along with great power, and a ride in a batteau is an exhilarating pleasure. The fall from Otter Tail lake to Fergus Falls is 144 feet, the elevation at Fergus being 1,181 feet above the sea. The general course of the river, as may be seen by a glance at the map, is generally southwest, but meantime the windings of the channel direct its current toward nearly every point of the compass. Its flood-plain as a rule is coextensive with its valley, which has been entirely eroded apparently by the present river.

The Lakes.

The lakes of Minnesota form a very conspicuous feature of our natural scenery. The traveller from his car window enjoys glimpses of their quiet beauty as they lie nestled among the trees or shimmering in the sunlight on the broad prairie. Hundreds of visitors annually make a pilgrimage to their shady shores to find rest and health and recreation. The multitude and variety of these fresh water deposits, and the influence they have on the life and health of the people call for a more minute description and extended notice of them than is usual in works of this kind.

Number of Lakes.

The number of lakes in Minnesota is variously estimated at from seven to ten thousand. The latter number is not too high if all the lakes in the unsurveyed northern portion of the State are reckoned in. In ascertaining the number of lakes in a given county, one must decide first what shall be included under the term "lake." There are broad shallow areas of water some eight feet deep, nearly filled with reeds and rushes. There are small round or oval depressions in the prairie, having no inlet or outlet, which in this State are included under the general term lake.

If we embrace everything which land surveyors and map-makers have considered of sufficient importance to be delineated on their maps, we have a total number of 3759 lakes of all sizes. But the region where lakes are most numerous, the northern and northeastern portions of the State, has been only partially surveyed, and there are no accurate maps of the country published. But from such information and data as we have, we have no hesitation in saying that there are within the limits of the State more than double the number of lakes already counted.

THE LAKES OF MINNESOTA AND THEIR DISTRIBUTION ACCORDING TO ANDREAS' ATLAS, BY W. UPHAM.

COUNTY.	No. of Lakes ½ mi. long or longer.	No. of Lakes less than ½ mi. long.	COUNTY.	No. of Lakes ½ mi. long or longer.	No. of Lakes less than ½ mi. long.
Ramsey	36	60	Isanti	27	1
Hennepin	66	32	Chisago	30	10
Washington	39	28	Todd	51	13
Dakota	11	1	Morrison	18	5
Scott	29	4	CrowWing	38	5
Carver	49	25	Aitkin	37	....
Nicollet	21	6	Wright	99	160
Brown	23	3	Meeker	109	62
Blue Earth	33	14	Kandiyohi	104	182
Le Sueur	50	18	Swift	16	....
Cottonwood	33	11	Chippewa	6	....
Murray	36	11	Lac qui Parle	4	....
Pipestone	....	....	Canby	....	....
Rock	....	....	Yellow Medicine	7	....
Nobles	16	5	Lincoln	39	9
Jackson	24	1	Lyon	17	3
Rice	21	10	Redwood	18	1
Goodhue	3*	2	Renville	15	1
Wabasha	2 mi.	....	Grant	43	34
Winona	2 mi.	2	Stevens	36	11
Olmsted	....	....	Traverse	2	5
Dodge	....	2	Big Stone	43	15
Steele	8	2	Clay	16	8
Waseca	20	16	Wilkin	1	....
McLeod	38	31	Becker	113	59
Sibley	32	7	Otter Tail	175	98
Freeborn	21	11	Kittson	1†	....
Watonwan	21	12	Marshall	....	....
Martin	60	6	Polk	5	....
Faribault	17	6	Beltrami	7	....
Mower	....	9	Itasca	43	6
Fillmore	....	1‡	Cass	181	25
Houston	1	....	St. Louis	36	....
Stearns	81	126	Carlton	8	....
Benton	3	2	Lake	5	....
Sherburne	20	3	Cook	13	....
Mille Lacs	6	....	Douglas	122	34
Anoka	43	40	Pope	61	29
Pine	34	7			
Kanabec	19	2	Total	2467	1292

Total of all sizes on Andreas' Atlas, 3759.

Including the lakes crossed by S. and E. county boundaries; but not those crossed on N. and W.

*Lake Pepin, &c. ‡Besides a mill pond. †L. of Woods.

Our lakes may be classified according to the character of their basins and the causes which have produced them, as follows:

A. The glacial or drift lakes, which occupy depressions, chiefly within the morainic area, between the hills of drift material Many of these lakes are very small and have no outlets. This class comprises the great majority of our lakes.

B. The fluviatile or river lakes which occupy basins on the course of rivers or within their valleys. Sometimes they are lagoons, marking the site of an ancient river-bed; sometimes they are enlargements of the river channel. Their number in this

State is quite limited. Not infrequently a lake seems to belong to both these classes.

C. Lakes having rock basins, which have been formed (1), by erosion, the glacier scooping out the softer rocks and leaving a channel or trough which has subsequently been filled by water, or (2), by the geological relations of different formations, which are tilted or otherwise disposed so as to leave a rocky basin.

The drift or glacial lakes are distinguished from each other in respect to the quality of the water. In some, especially those without drainage, lying in a clay soil and receiving their supplies from the adjacent watershed, the water is alkaline.

In those lakes, the shores of which are composed chiefly of sand and gravel, and which have free drainage, receiving their supplies by several creeks or inlets, the water is comparatively free from alkaline properties. It is the character of the soil which constitutes the water-sheds of a lake or river that determines the quality of the water. In the northeastern portion of the state, which is crowded with lakes and no inlets, the water is comparatively free from mineral impurities. Sometimes, as in that of the St. Louis river, the water is a dark wine color, caused by the leeching of the rainfall through spruce and tamarack swamps which the river drains. The soil in this region is mainly silicious. As quartz is soluble in rainwater, the rainfall comes to the creeks and lakes not nearly pure, or colored only by some vegetable extracts.

The great lacustrine areas of our globe are north of the 45°of latitude. Comparatively few important lakes lie south of this parallel in either hemisphere. By reference to the atlas, it may be seen that the lake regions of the earth are coextensive with the drift regions; that the countries which were once covered by the glaciers are the ones which now abound in lakes. Sweden and Switzerland, and Scotland and Ireland are examples in Europe.

In North America, the lacustrine area extends in a broad belt from MacKenzie's River southeastward to the Newfoundland. It includes the St. Lawrence system and the vast inland seas of British America, of which so little is known. Although these lakes belong to different river-systems, and vary widely in their geological relations, they have, I think, a unity of origin, and serve a similar purpose in the economy of nature.

Our Minnesota lakes lie on the southern margin of this area. There is a fixed relation between them and the morainic deposit in which they lie. They are most numerous where the evidences of glacial action are most abundant. The position of the great moraine might be traced from the northern bounkary of the state, south and southeastward through Beltrami, Becker, Ottertail, Douglas, Pope, Kandiyohi, Stearns, Wright, Hennepin, Carver and LeSueur, and south into Iowa, by the number of lakes which adorn the surface of these counties. It should be carefully noted that outside the limits of the morainic area, lakes are few, while within those limits, they are numerous. The northeastern part of the state also contains a vast number and variety of inland waters, some of them tributary to the St. Lawrence, and others to the Mississippi. These lakes are, many of them, of a different character, having rock basins, occupying clefts and troughs between differ entgeological formations.

ORIGIN OF THE LAKES.

The most uninstructed observer can see that large areas of the State now utilized as meadow-land, or under cultivation, were at no very distant day under water. The process of converting shallow lakes into swamps or sloughs, and these into solid, dry land, has been going on for ages, and is constantly taking place under our eyes. It is still more evident to the scientific observer that nearly the whole State was covered by an ice-sheet or glacier. The evidence on which this theory is founded, will be found in another chapter.

It is only necessary to remark here, that the surface features of our State with which we are all familiar, hill and valley, river courses, lakes and prairie undulations, were determined either during or subsequent to the glacial epoch. The lakes especially, are intimately related in a geological sense, to the glacial deposits. They were formed and their positions determined, by the same causes which produced the drift hills. One is as old as the other. They are both the children of the glacier. The principal hills of this State lie within the morainic area which marks the retreat and melting of the ice-sheet. Here also in great numbers and beauty, the lakes are found, nestled in the intervening valleys, occupying the hollows and depressions. Whence arises this companionship, which gives so much variety and loveliness to the scenery.

Let us try to imagine the condition of affairs during the closing of the glacial period in this State. The great ice mantle is slowly dissolving before the gentle assaults of a milder climate. Its retreat is not rapid, and is frequently interupted for a time by the return of winter. Some portions of the glacier are more heavily loaded with the material of which our hills are composed, than others. These parts melt faster than the purer ice. The result is that cakes of comparativly clear ice lie between the great dark accumulations of gravel, boulders, sand and clay. Torrents of water, caused by the melting, flow from the foot of the glacier which fill up every depression and nook of every sort. These are constantly at work modifying and rearranging the materials which the ice has deposited. Only superficial portions of this material are subject to this modification by water. The deeper deposits, the *moraine profonde* is undisturbed. The coarser gravels and boulders are only slightly stirred, and arranged in a rude stratification or thrown pell-mell into some cavity in the clay. The finer gravels and coarse sand are carried further and spread out in thin layers on some old flood plain, while the lighter and finer sands are carried by the great flow of water far down into the river valleys. Over all hung clouds and mist, while descending rains and fierce winds swept over the wild and dismal scene. But at last all this comes to an end. The glacier is melted. The surplus water is carried away. The hills with their softly rounded outlines and steep slopes, stand forth clothed in verdure, while around their bases, and filling the deeper depressions, the lakes, somewhat in their present form, though deeper and larger, are all that remain of the glacial flood.

CAUSE OF PERMANENCY.

Our lakes have remained a fixed feature of the landscape since glacial times, for the reason that the slope of the watershed is so slight and the erosion by rivers and outlets so little. When a depression in the earth's surface is once filled with water, it remains a permanent lake so long as the drainage and evaporation do not exceed the amount of water received from the rainfall and other supply sources.

The character of the basins of the glacial lakes of Minnesota also tends to secure permanency. The slope of the bottom from the shore toward the center of the lake is usually very gradual. The deepest water is generally found about the center. Many lakes lie in separate basins connected by a narrow channel. The clay which constitutes the bottom of a large number of lakes is very hard and compact. The blue clay especially is almost impervious. These conditions combine to hold the supply of water securely. It follows from these considerations that the lakes, when once formed, must remain, since the agencies tending to destroy them are not equal to the sources of supply and stability.

Moreover, it is evident from a careful consideration of a multitude of lake basins, that the annual mean rainfall has been for a long period about what it now is; that the lakes received more of that rainfall than they now do. The loss by evaporation and drainage together did greatly exceed the supply. The lakes very generally held their own or receded very slowly from their ancient levels.

Our lake shores are rude meteorological registers. They show that the same conditions of climate, of cold and heat, of moisture and dryness, that exist now, have prevailed for centuries. A lake once formed, remains at a constant mean height, so long as the agencies tending to destroy it are counterbalanced by steady sources of supply.

CAUSES WHICH OPERATE TO DIMINISH THE NUMBER AND SIZE OF OUR LAKES.

It is, however, beyond question that the present tendency of our lakes is to retreat within narrower compass. A very wet season brings them up for a short time to the vicinity of the old high water mark, but they never reach it, and they quickly recede again to their usual low levels. The shallow lakes which have no visible inlet or outlet are slowly drying up. Those which form a part of some river system, which receive the drainage of some lakes or have other regular sources of supply will maintain their present level indefinitely. But there are a large number of shallow lakes which are rapidly being transformed into marshes. In a few generations, probably, they will become excellent meadows.

Among the causes which co-operate to produce this change, the agency of man is perhaps the most powerful. Before the settlement of the country the lakes and streams received a larger share of rain fall directly. The undisturbed prairie sod sheds water almost as well as the roof of a house. Any one who has driven over the unbroken rolling prairie in a wet June and on a rainy day when the pools are full has seen the water rushing along over grassy hollows and in gentle depressions where no water-course would be suspected in a dry season. Thus, when nature operated without interference, the rainfall speedily found its way over the grassy prairie sod into the lakes. But when then the farmer came with his plow and tore up the sod and cultivated the fields the water remained nearly where it fell and the lakes also "fell" correspondingly. Their supplies were cut off in every direction by the growing crops which formerly found their way directly into the lakes and streams.

The growth of water-plants and reeds also tends to fill up the lakes. The bottom of nearly all the shallow lakes is covered by a thick matting of trailing plants, some of which are interesting and beautiful. Nothing can be more graceful than this sub-aqueous vegetation. Leaning from the side of a boat on a calm day in summer one may feast his eyes on little and delicate forms of beauty growing in minature forests and jungles, where the larger bass and walleyed pike love to lie in cool and shady seclusion. But all this luxuriance of vegetation tends to transform the lake which covers and protects it into an unlovely morass.

There is no evidence, and we have not the data on which to base a conclusion, that the rainfall a century ago in Minnesota was greater than it is now. But the lakes are certainly drying up. The rate of the recession of the water is greater since the advent of civilization than it was before. The rainfall continues about the same since 1836 when observations were first taken at Ft. Snelling.

The inference is that a smaller share of the rainfall reaches the lakes now than formerly. It is absorbed by the growing crops. It has been ascertained by careful measurements and repeated experiments in France that it requires the expenditure of from 800 to 2,400 pounds of water to produce one pound of wheat. When the ground is rich in the chemical constituents of the grain less water is required. This may account for the fact that the lands in the Red River Valley, where the mean annual rainfall is only 17 inches, produces 30 to 30 bushels per acre. Where the soil is inferior, as much as 15 inches is required between seed time and harvest by a crop of wheat or oats.

ACTION OF ICE ON LAKE SHORES.

One of the constantly recurring features of the shores of most lakes is a low ridge or embankment of sand, gravel and boulders, running parallel with the water line, and distant from it from ten to sixty feet. Sometimes there are three or four of these ridges, at various distances from the water. The outer one, if undisturbed, is the highest and not uncommonly supports trees of large size. These "embankments," or "walls" as they have been called, have excited the curiosity of people a good deal and there has been much lively speculation as to their origin. Some have supposed they were thrown up by the primitive inhabitants of these lands —whoever they were—for roads. But a very little attention to facts is sufficient to convince any one that these ridges are due to the action of ice, aided, in some cases, by the high winds and waves of early spring. When the lake freezes in winter, the shallow parts about the shore freeze first. The ice takes up in its frigid grasp all loose stones, pebbles, grains of sand and dirt lying at the bottom and around the margin of the water. But this shore-ice is not permitted to remain in the position where it was formed. A mechanical pressure is brought to bear on it by the further freezing of the surface of the lake. It is lifted and pushed up on to the beach by expansive force of freezing water.

The phenomena of the formation and effects of lake-ice are so interesting that a brief account of them is given with a view not only of explaining the walls and ridges about our lake-shores, but with the hope of inducing those whose good fortune it is to reside near a lake, to observe more closely the facts and phenomena for themselves.

PHENOMENA OF FREEZING.

To take a special case, Lake Minnetonka froze over in November, 1880, earlier and more suddenly than is usual. The first ice formed around the edges of bays on November 7th. Several days of stormy weather, rain, snow and northwest wind, followed, and the lake was very rough, nevertheless the ice continued forming more and more in the bays. The temperature of water at the surface was continually falling. On the first of November it was 45° F., and on the 16th it was 37°. Then came a storm and very cold weather. The thermometer registered 7° below zero on the morning of the 17th. Excelsior bay and Gideon's bay froze over, and on the 19th the entire lake was covered with ice, the thickness being six inches about the shores and two inches further out. During the night on the 20th inst., the ice cracked in many places with a loud report. Exquisite ice-flowers, sometimes an inch broad, appearing like a miniature forest, were very numerous. These are all modifications of the typical, six-rayed ice-star.

I have given this brief account of the sudden freezing over of one of the largest of our lakes in the middle of November because it is an illustration of what took place on all the 10,000 lakes at the same time.

It is a well known principle that frozen water requires more space than the same amount did in the liquid form. Water in freezing expands.

Water attains its maximum density at 39° Fah. Below this point it expands. At 32° fah. it begins to turn into crystals of ice, which float on the surface because comparatively lighter than the water. At 32° the expansion by cold terminates, but in the final act of solidification the expansion or increase of bulk is sudden and irresistible. Conceive of a large lake like Minnetonka freezing over to a depth of two to six inches in twenty-four hours. A vast quantity of water is turned into ice every hour. The expansive force of the crystalizing water is exerted in every direction at once. The strain is tremendous. The ice cracks and loud reports are the accompaniment and evidence of this action.

As the cold of winter continues and increases, the ice becomes thicker and the increase of bulk continues to demand room. The ice in the borders of the lake is now pushed by inherent force of the great mass up on to the shores, carrying with it rocks, pebbles, and whatever it may have caught in its grasp. The broken ice on the edges of the lakes is a familiar sight. The causes which produce these phenomena are here indicated.

In these low embankments or ridges of gravel and sand about the shores of lakes, we see the effects of years, perhaps of centuries, of ice action. When the lake stood at a higher level than it now has, the ridge most remote from the present shore, was slowly formed by causes identical with those now at work. Year after year the ice crowds upon the shore with its weight of sand and gravel, here from the bed of the lake. Winds and high waves assist in the process and thus, in the course of successive seasons, a very large accumulation of material is formed.

The line of boulders along the shores of some lakes, deposited with an apparent regularity that makes them resemble, at a little distance, a low stone wall, is due to the action of ice. These boulders are scattered through the drift formation, which constitutes usually both the shores and the bed of the lake. Where the shores are high and abrupt, the boulders sometimes fall from above into the lake. Whenever a loose stone comes within reach of ice it is taken and moved about, lifted up and shoved upon its fellows.

Value and Utility of Lakes.

The value and utility of our lakes are not to be computed according to the market price of the land adjoining. They constitute together a natural feature of the state which, like the salubrious and invigorating climate, the fertile soil and vast forests, is a part of the common wealth. No matter who owns the adjacent acres, the lakes themselves are public property, and we are all richer and happier because they are here. They have however a definite utility in two or three respects that demand mention.

1. The sanitary or hygienic value of our lakes should be recognized. Whatever contributes to promote the health and happiness of the people, is important. The lakes furnish a constant opportunity and temptation to the residents both of city and country to take hours of healthful exercise and recreation. They are usually well stocked with fish, and haunted during the autumn months by myriads of wild fowls. Aside from their attractions for the sportsmen, there is, for all classes of people, a relaxation from mental and physical strain, a wholesome pleasure, a recuperation and invigorating effect produced by spending a few weeks or even a few days on and about these lakes. Health is capital; and beyond question, our people derive from these crystal waters a fund of enjoyment and vitality which materially augments the prosperity of the State.

But the charms and benefits of the lakes of Minnesota are recognized and appreciated quite as much by the citizens of other States as by our own people. Every summer. in very increasing numbers, they come from all parts of the Mississippi valley, from New Orleans, from Memphis, from St. Louis and elsewhere to find a stimulating climate and healthful recreation at our lakeside resorts. And what an immense number of such resorts there are which are unoccupied. The capacity of Minnesota to set forth entertainment in this line, is inexhaustible. Thousands of beautiful lakes scattered over the whole lake district invite the tourist, the sportsmen and visitor to their shores. There is room for all. We might almost say that there is a lake for each one. When the resources and beauties of our inland lakes become more widely known, their practical value as a source of income to our citizens will be better appreciated. To make these lakes more accessible to provide boats and comfortable houses of entertainment, is one of the natural and legitimate industries open to our people.

2. The climate is modified to some extent, by the lakes. Dur-

ing the summer these small bodies of water become reservoirs of heat. The temperature of the lakes during the summer months, as determined by repeated observation, is about 75° Fah. The whole mass of water is heated alike; the temperature of most lakes at the bottom is the same, nearly, as the top. The capacity of water for absorbing and retaining heat is well-known.

During the summer, heat is absorbed from the direct rays of the sun. During the fall, up to the hour when the lake freezes over, this heat is slowly given off and exerts a sensible influence on the surrounding atmosphere. Gardens and vines favorably situated on a lake side escape the frosts of autumn longer than others. No doubt the transition from summer to winter would be more abrupt and severe but for the large amount of heat latent in water which is given off in freezing. "Every ton of water converted into ice gives out and diffuses in the surrounding atmosphere as much heat as would be required to raise a ton of water from 32° to 174° F."

3. In many instances lakes have been utilized as reservoirs from which to draw supplies for mills and factories as necessity requires.

By constructing dams at the outlets a vast amount of water may be stored during the spring and early summer in these natural reservoirs. The value of water powers may thus be greatly increased. Among the plans contemplated by our national government for the improvement of navigation on the Mississippi river is that known as the "reservoir system." It is nothing more than the utilization of the lakes and marshes of the upper Mississippi above Pokegama Falls, for the purpose of storing water during the winter and spring, up to July 1st, so as to maintain during the season of low water from July to November a steady stage of water at St. Paul and below, sufficient for all purposes of navigation. A further account of this proposed system of reservoirs is given on another page in the section describing the headwaters of the Mississippi.

Although with few exceptions lakes are distributed in all parts of our State they are far more numerous and interesting in the central and northern counties. The belt of country, which by reason of the great number and beauty of its lakes deserves the name of the *Lake District*, begins with lake Minnetonka, in Hennepin county, and extends northwest to the northern line of Becker county. The district is from 30 to 50 miles wide. It is bounded on the south by the Breckinridge division of the St. P. M., & M.

R. R., while the Fergus Falls division of the same road passes directly through it. The Northern Pacific R. R. passes through the northern limits of the district.

Another lake district exceeding in extent of territory and in the number of lakes the one described above, begins in Becker county and extends east and northeast through Cass, Itasca, St. Louis, Lake and Cook counties to the chain of lakes which constitutes the boundary line between the U. S. and Canada. In this district lie the head waters of the Mississippi, the Red River of the North and the St. Louis river. These lakes will be described when we come to consider the hydrographical basins of the rivers in which they are situated.

At present we will give an account of the lakes in the first district mentioned, which lie partly in the water-shed of the Mississippi and partly in that of the Red River. For the purpose of assisting those who are not familiar with the geographical position of the lakes to locate them readily on the map, I shall describe the lakes in the several counties of the district.

Lake Minnetonka is one of the largest, as it certainly is the most widely known and celebrated, of our lakes. On account of its accessibility it monopolizes the admiration which would be shared by other lakes equally charming, but for their remoteness from railroads and large cities. There is, however, no lake in the State that excels Minnetonka in that general attractiveness, which is a happy combination of clear, wholesome waters, hard, pebbly and sandy beaches, shady, wooded shores with irregular outlines and unequal heights, points, promontories, islands, bays, in short, a delightful interlocking of land and water.

The lake occupies a series of depressions in the great moraine, which at this point bends south, and extends down into Iowa. Minnetonka is a name which includes a cluster of bays and lakes more or less connected together by shallow straits. The upper and lower lakes are quite distinct, only a narrow and crooked channel uniting them, which has now, however, been straightened and deepened to allow the passage of steamboats.

A little attention to ancient water marks and ice action about the shores, will convince the close observer that the level of the lake was formerly much higher than it is now. There was once a broad, though probably rather shallow, belt of water between the upper and lower lakes, which is now so filled with rushes and reeds and grasses that it has become a morass. All about the shores are swampy places, some of which have become almost dry land, where the lake once held undisputed possession. Many lakelets which now have no connection with the main body of the lake, except perhaps in time of very high water, were at one time arms or branches with clearly marked water communications. The former level of the lake was probably five or six feet above the high water mark of the present time. A remarkably fine lake, however, remains, and one which is in no immediate danger of drying up, although a constant diminution in the area of water surface is going on. The depth of water varies greatly in different localities. The bottom of the lake is very irregular. There are valleys and ridges beneath the surface of the lake corresponding to those above. A great number of soundings have been taken and registered, some of which are given on the maps which accompany this report.* In the lower lake the deepest parts are in the centre of the largest basin, that is, the area included between the lower end of Big Island, Starvation Point, Lookout Point and Gibson's Point. The depth in this basin varies from 40 to 70 feet.

Brightwood or Gale's Island is the summit of a little hill which rises from 50 to 75 feet above the bottom of the valleys that surround it on three sides.

Crystal Bay is deep; both above and below Cedar point, the water fills a basin the bottom of which is from 40 to 70 feet below the shore line.

The upper lake is deepest between Halsted's place and Enchanted island. The water in the basin is from 50 to 70 feet deep. The bays generally are shallower, showing not more than 25 or 30 feet of water usually, in the deeper parts. On the bars and ridges there are from 4 to 10 feet of water.

Wright County

adjoins Hennepin on the northwest. It is drained chiefly by the Crow river. In the northern part of the county, the Clearwater river, with the lakes of which it is the outlet, drains a considerable area. There are 160 lakes within the limits of the county, of which Clearwater lake is one of the largest and most celebrated and attractive as a summer resort. It is the lowest of a chain of lakes on the Clearwater river. Its position makes it the reservoir of the watershed of the river above it and keeps it supplied with the drainage of an extensive region. The quantity or volume of water in the lake therefore varies but little. It differs from a large number of lakes which we shall have occasion to describe, in maintaining a more equal and constant height from year to year. A lake through which a river flows, has the conditions of a more permanent and stable existence than one which depends for supply only on its own water-shed.

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*This map is reserved for future publication.

The northern part of the lake is generally shallower than the southern. There are large areas where the water is not more than four to six feet deep and aquatic plants flourish. In the deeper parts from 25 to 40 feet of water were found, and in one place 54 feet, but these deeper areas were quite limited in extent. In the northern basin are two islands, covered with trees andshrubs. They are the summits of little hills whose bases are covered by the lake.

The surrounding country is rolling and uneven. Around the southeast part of the lake the shores rise abruptly from 10 to 40 feet. At other points the shore is low and level. There is comparatively little marsh except where former lakelets have succumbed to the influences which are silently yet surely drying and filling up every lake in the State. The inequalities of the lake basins, as revealed by the sounding line, are only a part of the general contour of the surface of the country.

The lake is divided by a bar into two nearly equal parts. The bar is a low ridge of gravel, rising but few inches above the lake level. The water on either side for some distance is shallow, and then suddenly falls off to a depth of 30 to 50 feet, showing that the bar is the crest of a hill or ridge. The channel at the end of the bar, connecting the two parts of the lake, is from 28 to 38 feet deep and about 30 to 40 feet wide. Thus there are two distinct basins. The southern basin varies in depth from 4 to 60 feet. The bottom is very irregular, in some places, as at Longworth's house, sloping gradually down and at other points falling off abruptly. Some of the deepest water is across the lake from Longworth's and four or five rods off shore. The greatest depth measured was 60 feet, and from 30 to 50 feet were found repeatedly.

Meeker County

lies west of Wright, and south of Stearns. It is drained by the Crow river, the north branch of which flows through the northern half of the county, while the south fork drains the southern townships. Between these streams, and generally connected with them, are a great number of small lakes;

about 110 in the entire county, and as many as 170 if we include the smallest.

One of the largest is Lake Ripley near Litchfield. It is about two miles long and a mile wide. The country around the lake is either level or gently rolling. The Litchfield prairie is nearly level. There is only a difference of two feet in elevation between Darwin and Litchfield.

Lake Ripley

occupies a very shallow depression in this prairie. The bottom of the basin is level and slopes very gradually down from the water's edge, to a depth of 20 feet.

There is evidence about the shores that the lake formerly stood at a higher level than it now reaches, even at high water. The ancient shore-line is clearly marked. There is an accumulation of gravel and boulders at several points, which must have been deposited by the action of ice and water, that is from 3 to 5 feet above the present level, and from 20 to 50 feet distant from the present water line.

The outlet of lake Ripley in time of high water is into the Crow river. It depends for supply, on its own water shed and the drainage of an extensive slough adjacent.

Lake Minnabelle

is about six miles south of Lake Ripley. It has no apparent outlet. It lies in a deep basin of considerable depth, and surrounded by a rolling prairie country. The greatest depth found was 43 feet, in the central part of the lake. There seemed to be quite a uniform depth of 25 to 40 feet. The bottom of this basin must be in the clay, as borings for wells near the lake indicate that the clay extends down for at least 90 feet. This clay at the depth of 90 feet, became so hard that the attempt to get water, was abandoned.

The basin of Minnabelle may be regarded as "water-tight." The evaporation from the surface is small in proportion to the whole amount of water in the basin, and the annual rainfall keeps the supply constant.

Washington Lake.

is near Darwin on the west side of the belt of timber known as the "big woods." It is entirely surrounded by forest. It has an area of about 4 square miles, and is supplied by the drainage of two small lakes lying west of it and constituting the headwaters of a creek, which enters the Crow river below Kingston.

The shores are unequal and irregular in height, varying from 6 to 30 feet. The depths of the lake, so far as they could be ascertained, also vary from 6 to 18 feet. Large areas of the lake are quite shallow, with a luxuriance of water plants.

Kandiyohi County.

For convenience in description the lakes in the southern part of this county may be grouped together. They possess in common the characteristics which are noteworthy. The surrounding country is a gently rolling prairie which slopes very slightly south toward the Minnesota valley. There are no high hills or deep valleys. The shores of the lakes slope very gradually to the water line or are entirely flat and featureless. The lakes are Lillian, Big Kandiyohi, Elizabeth, Little Kandiyohi.

They are all shallow, varying in depth from seven to twelve feet in the deepest parts. The water is slightly yellowish in color and alkaline. They lie on clay bottoms, over which is a thin deposit of sand. The temperature of the water was 74° F. on the 28th of June, when the temperature of the air was 67° to 70° F. They have no large inlets from perennial streams. They receive the drainage of contiguous sloughs, and in very high water they form a temporary outlet into the south fork of the Crow river, which has its ultimate sources in these lakes. There is a difference of only about one foot between the levels of these lakes. Kandiyohi and Elizabeth are a trifle higher than Lake Lillian.

There are no forests in this part of the county. There is a fringe of trees about the shores of the lakes and some valuable groves of oak, ash, elm, box elder, basswood, poplar and a few hickory trees. I also observed the wahoo growing here. In Lake Elizabeth are two islands, and on the western side the prairie slopes down rather abruptly, giving a picturesque and pleasing effect.

The lakes in the northern part of Kandiyohi county are of a different character. The country, as a whole, is more hilly and uneven. The moraine, traced by Mr. Upham, enters the county from the northwest, and extends entirely through the northern part. This morainic tract is in some places, very rough and broken. The hills are from 100 to 150 feet above the lake levels.

Dover hills are about half way between Willmar and Norway lake. The summit of the highest commands a fine view, and is about 150 feet above Foot lake. Several other hill-tops north and west of Green lake were measured for altitude by me, and found to be from 1200 to 1350 feet above the sea. One of the highest of these summits is on the north side of Green lake, and commands a very extensive and magnificent view. It is 200 feet above the lake level.

In this part of the county there is considerable timber and woodland. Hundreds of acres are covered with valuable forest trees. The principal varieties are oak, basswood, elm, ash, ironwood, poplar, cottonwood, hackberry and box-elder. Around Eagle lake there are some butternut trees. The principal shrubs and small trees observed were plum and cherry trees, prickly ash, gooseberry, wild currant, juneberry, red-raspberry, black-raspberry, cornus, elder, snowberry and wild grape.

Although a good deal of attention has been given to the subject of tree-planting in this county, and some fine young groves are to be seen, yet the farmers as a whole are painfully short sighted in this respect. So long as there is wood enough for present necessities, no earnest effort will be made.

Men care little for the future. They seem content to live on the bare, bleak prairie without a tree or shrub about them, rather than make the necessary effort to have a thrifty grove of forest trees growing up about them.

The old forests at present are disappearing much faster than the new ones are growing. Indeed, nothing that can ever be called a forest is attempted. Only a few acres of cuttings are set out here and there. These are in many cases neglected and destroyed by drought or fire.

Some more vigorous effort must be made, either by legislation or by town and county action, before this matter of tree culture will receive the earnest attention which its importance demands.

The largest body of water in the county is Green lake. It is about four miles long—east and west—by three miles and a half wide. It derived its name from the color of the water, which at times is intensely green, changing to blue, purple and darker hues. The unceasing play of color in the water is one of the great charms of this very beautiful lake. The principal inlet is at the northwest corner, where there is a flour mill. The outlet is at the northeast corner. It discharges into the north fork of Crow river.

There is a bar about the middle of the lake running nearly across.

I did not sound the lake in all its parts, but found in the western half 40 to 50 feet of water of the purest quality. The temperature, July 1, 1880, was: Air 78° F. water 74° F. I did not discover any appreciable difference in temperature between the water at the top and at the bottom of the lake.

Fluctuations in the water level appear to depend on the amount of rain-fall. Within the last ten years it has been from 10 to 12 inches lower than now, and also from 6 to 8 inches higher, according to the season.

Green Lake lies in a depression at the foot of the moraine which sweeps away on the north side toward the east and on the west side toward the south. Its position with reference to these hills and the country north is such that it must remain a permanent reservoir.

Its shores are bold and abrupt on the north and west sides—more level on the east and south sides. Near Mr. Aspenwall's the bluff is forty to fifty feet above the water.

ACTION OF ICE ON THE SHORES.

Beautiful illustrations of the action of ice in piling up sand and gravel are also to be seen here. The ancient ridge is now a roadway and has large trees growing on it. It is 40 to 60 ft. from the water. The most recent ridge is close to the water's edge. It is four or five feet high and five to eight feet wide at the base. It is composed of fresh gravel and has been thrown up within the past four years.

Between Green lake and Willmar there is a chain of lakes.

Eagle Lake.

Of these I shall only describe Eagle lake, which is about four miles north of Willmar. It lies in a depression at the foot of a spur of the great moraine. Its waters are clear and sparkling. Its northern shores high and picturesque and well wooded. Some of the hills are from 75 to 100 feet above the lake. Its outlet in high water is at the south end, and it drains into Swan and Foot Lakes.

There are springs about the northern shores and a small inlet from a slough or drained lake, on the east.

Its altitude above the sea is about 1125 feet.

Foot lake, at Willmar, is very shallow, and the waters in summer very impure, full of decaying vegetable matter. It is partly filled with a vigorous growth of reeds, and its days as a lake are nearly numbered. I sounded it in several places, and found a depth of 6 to 12 feet. It has receded from its former limits very perceptibly since the town was started. It is now at least five feet lower than it was in 1857.

Diamond Lake.

Diamond lake is a clear and beautiful sheet of water about five miles southeast of Green lake. The prairie around is massive, rolling, with no abrupt hills. The lake is two to three miles long and a mile or more wide. The greatest depth found was 26 feet. The temperature of the water on July 2, was 74° F., air 71° F. at sunset. Its outlet joins that of Green lake. The shores slope gently to the water's edge and bear a fringe of native forest trees. Evidences of a former higher lake-level are abundant.

In the northwestern part of the county is a chain of very charming lakes. These are Norway lake, James lake, Swan lake and Lake Andrew.

The moraine trends along the north side of these lakes. They lie in a series of depressions at the southern base. All the country south and west is massive, rolling prairie.

Norway Lake.

Between the lakes and to the eastward there is considerable hard-wood forest. Norway lake is not deep, and at the time I visited it, October, 1880, there was a minimum stage of water. There is a depth of 30 feet in some places. It is well cut up with bars and points. One of these, belonging to Mr. Even Railson, is a mile long and covered with fine hardwood timber. The margin of the lake supports a thick growth of reeds and rushes. The water is clear and translucent. In the fall it is the abode of thousands of water-fowl, and is a sportsman's paradise. Evidences of former higher water are very abundant. The old beaches are clearly defined. I am told that in 1871 the lake was six feet higher than it is now, and also in 1860 there was a very high stage of water. At such times these lakes have an outlet southwest into the Chippewa river: but in a dry season and low water there is no outlet. These lakes usually freeze over between the 1st and 15th of December, and open in the spring between the 1st and 15th of April. The temperature of the water, October 10th, was 63°F. Lake Andrew is deeper than Norway, and there is a great variety of shore line. Together these lakes constitute one of the most delightful groups in this region.

The natural drainage of Kandiyohi county is chiefly into the Crow river. The northeastern townships are drained by branches of the north fork, while the southeastern towns, south of the railroad, are drained by the south fork. The western tier of towns are drained by branches of the Minnesota river, the Chippewa and the Chetomba. There is not an exposure of rocks in the whole county. The drift, which is very heavy, undoubtedly overlies the archæan terrace, which extends across the State from Lake Superior southwest. The "summit" near Atwater, where the railroad grade reaches an elevation of 1.264 feet above the ocean, is probably due to the greater uplift of the underlying rock rather than to any greater thickness of the drift. The drift pebbles on the shores of lakes are granitic or gneissic and limestone, about 65 per cent. of the former to 35 of the latter.

The principal lake of Pope county is Lake Whipple. It has an average length of seven miles, and width of two miles. Its area is about 15 square miles. It is situated in the northern central part of Pope county. It lies very picturesquely at the foot of the great moraine, at an angle where its development is most typical. On the north and eastern sides the morainic hills rise irregularly above the lake to a height of from 50 to 200 feet. At the northern extremity of the lake the quiet little village of Glenwood consists of a few houses at the foot of the bluff. Going up to the top of this bluff, which is more than 200 feet above the lake, one may enjoy as delightful a bit of natural scenery as there is in central Minnesota. From this summit the prairie stretches back to the north and west quite flat and featureless. Lake Whipple seems to occupy the bottom of a great basin around which the morainic hills of unusual boldness and height gather on every side, except the west, where is the outlet of the lake into the Chippewa river. The depth of Lake Whipple, at the northeastern end, near Glenwood, varies from 12 to 30 feet. It is quite shallow along the western shores, and there are a number of sloughs and lakelets which drain into the larger lake. There are numerous springs about the northeast shore, and water is found in the wells of the village at depths of 14 to 40 feet. The water stratum is of sand underlying a bed of blue clay. The temperature of the water, on the 13th of July, was 77° F.

Lake Reno.

Lake Reno, on the northern boundary of Pope county, is a prairie lake about four miles long and two miles wide. Its northeastern extremity is much narrower. It has an area of about six square miles. It is separated by a sand-bar, from Maple Lake on the north. The surrounding country is rolling prairie nearly level. The banks of the lake show a subsoil of light yellowish clay. They are not more than 10 to 15 feet above the water, and usually slope gently back, without any abrupt or precipitous shores at any point. The lake has an even clay bottom, and in the central part, has an average depth of about 20 feet. There are very few reeds or rushes and no islands. At the northeastern end there is considerable timber, the principal forest trees being the oak, maple and basswood. The larger portion of the surrounding country is prairie. The water is slightly alkaline and of a yellowish hue, characteristic of broad and rather shallow lakes which are easily stirred to the bottom, by the winds. The temperature of the water, on the 28th of Aug., was 72° Fah. The outlet of this lake in high water, is into the Chippewa river. Its inlets are temporary streams from the adjoining prairies and sloughs.

Douglas County.

The lakes of Douglas county, are unsurpassed for the purity of their waters, the beauty of their scenery and general attractiveness. A glance at the map will show that there is a large number of them. But it is not their number so much as it is their beauty and variety which impresses any one who studies them in detail.

NATURAL DRAINAGE.

The western half of Douglas county is drained by the Chippewa River and its tributaries, while the eastern half is drained through the Long Prairie Chain of lakes into the river of that name which, beginning at Lake Carlos, of which it is the outlet, flows east and then north through Todd county, and discharges into the Crow Wing river near Motley.

TOPOGRAPHY.

The "leaf hills," whose greatest developement is in the southeast part of Ottter Tail County, are represented in the northern townships of Douglas. There are some conspicuous eminences on the north and west shores of Lake Christina. These hills rise from 75 to 150 feet above the lake. The highest point reached by the railroad near the southern boundary of the town of Lund, is 1378 feet above the sea.

Lake Christina is about 1215 feet above the sea. The general average of hill and valley is between 1230 and 1350 feet above the ocean. Evansville station which is one mile south of the town line, has an elevation of 1354 feet, and the Chippewa river near Stowe's Lake, is 1339 feet above the sea. Some of the highest points in the town are on sections 23, 25 and 36. The northern sections of the adjoining town of Millerville, are high and hilly. The township of Leaf Valley as its name implies, is a broad basin.

In Miltona a range of morainic hills extend southwestward past Lake Miltona and west of Lake Ida, through the town of Mohr to lake Oscar and beyond. At lake Oscar are some very prominent and massive hills, rising from 100 to 200 feet above the lake. This central ridge of the country is the "divide" separating the waters which find their way into Long Prairie river from those which flow westerly into the Chippewa. Alexandria which is situated on a high prairie a little east of this central ridge, has an elevation of 1392 feet. Lake Ida is a little more than 1400 feet above the sea.

The Long Prairie Chain of Lakes.

In the eastern half of Douglas county there is a chain of lakes remarkable for their purity, depth and beauty. They are all connected and lie within a radius of a dozen miles of Alexandria. Beginning with the most northern and the highest of the chain, they are Irene, Miltona, Ida, Louise, Mill, Andrew, Mary, Lobster, Fish, Latoka, Cowdrey, Darling, Union, Bergan, Childs, Victoria, Geneva, Le Homme Dieu, Carlos. Only the largest and most important of these can be mentioned.

Lake Miltona

is the largest of the chain. It has an area of about nine square miles. It is six or seven miles long from east to west, and about two miles wide. It has two inlets, one at the eastern extremity and another at the northwestern. Its outlet on the southwestern side discharges into Lake Ida. The lake has an elevation above the sea of a trifle over 1400 feet. Its shores in many places are bold and rise abruptly 20 to 40 feet above the water. They are covered with forests except in a few places. The leaf hills to the north, dun and hazy in the distance, are seen from centre of the lake. There are large areas of the lake which are shallow and the bottom is covered with a dense growth of aquatic plants. Although a number of soundings were taken in different parts of the lake, only one place of considerable depth was found where the line showed 80 feet of water; this was a little south of the centre. Other parts showed 30 to 50 feet, but the majority of soundings gave 14 to 25 feet. Owing to the amount of vegetation growing, the water is not as free from foreign matter as some lakes. It is, however, clear, sparkling with no tinge of yellow. There are some fine springs on the shores of this lake, and some stately forest trees, sugar maple, elm and basswood are flourishing. The temperature of the water on the 10th day of August was 75° F. on the surface, 73.5° F. at the bottom. Air 80° F.

Lake Ida.

Next in size and order is Lake Ida. It is four and a half miles long and one to one and a half miles wide. It has an area of about five square miles. It lies east of the central drift ridge, which divides the waters of the county. The surrounding country is massive rolling drift, and on the eastern side is well timbered. The water is very pure and crystalline. The shores are strewn with pebbles and small sub-angular boulders. There are very few reeds and rushes. I found the temperature of the water on the 16th of August to be 73° F., air 81° F. The inlet of Lake Ida is at the northern end, where it receives the surplus water of Lake Miltona. The outlet is at the southeast corner, at Alden's flour and saw mills, whence it flows south.

Lake Latoka.

This charming little lake is only two miles from Alexandria. It is about one and a half miles long, and half a mile wide. It lies in a deep and quite uniform basin. It has an average depth of fifty feet, the greatest being eighty feet. The bluffs around the north end at the outlet are from two to thirty feet high. The soil is sand and gravel, including some boulders. The water is remarkably pure and of a deep bottle green color. The surrounding country is covered with forest.

Lake Cowdrey.

A few rods north of Latoka is smaller in area but a very pretty lake. Here the surplus water from some twelve or fourteen other lakes combine and send a deep strong current north to Lake Darling.

Lake Darling.

A sheet of water two miles long and a mile wide, surrounded by forests of stately trees, dry and bold shores, divided by a bar near the northern end into two basins, almost two lakes, this is Lake Darling. The inlet at the southern extremity is a deep, strong current pouring continually into this lake the surplus waters of a dozen others. The depth varies from sixteen to fifty feet. The water is clear and pure.

Lake Victoria receives the drainage from half a dozen smaller lakes at the south. There are two arms, an eastern and western, both have inlets and combine to form the main body of the lake. The western arm is much the larger. In this basin the great mass of the water lies. Its depth, near the center, varies from 40 to 50 feet. The east arm is 30 to 40 feet deep. Near the outlet the water becomes shallow and reeds are numerous. In the center of the lower part of the lake the depths vary from 22 to 38. The water is not very pure; it contains a considerable amount of decaying vegetable matter, brought down from swamps and shallow lakes above. The shores of the Victoria are generally high and wooded. The banks where exposed, are clay. A very short outlet, crossed by the St. P. M. & M. R. R. brings us to the next link in the chain.

Lake Geneva is nearly two miles long and half a mile wide. Its waters are clearer than those of Victoria. In some parts it is also considerable deeper. Soundings varying from 30 to 60 feet were made in the south half of the lake. There is clay in the surrounding bluffs which arise 10-20 feet above the water. The R. R. has made a long, high "fill" at the inlet. In consequence of these facts the water holds in suspension considerable earthy matter, giving it at times a faint yellowish tinge.

One of the charms of this chain of lake and the country adjacent is the presence of fine, large, forest trees which the ravages of the "woodman" have not laid low. For this reason the shores of these lakes are particularly attractive as places of resort in summer and are capable of such improvement at small expense, as would make them delightful places of residence.

Lake Le Homme Dieu.

This lake has a quite irregular shape and lies in two distinct depressions of unequal depth. The long point that runs out from the west side is continued under water by a bar extending more than half way across the lake. In the southern basin, not far from the inlet, the water is from 60 to 75 feet deep. In various parts of this basin depths varying from 25 to 57 feet were found. The lower basin at the north end of the lake is larger and includes a deep bay on the west side, but on the whole this portion of the lake is shallower than the other.

As a whole it is one of the mose beautiful sheets of water in Minnesota. The shores are moderately high and well-wooded. It is separated only by a narrow bar from Lake Carlos. The water is clear and pure. In this respect there is a gradual improvement as we proceed down the chain. Geneva is purer than Victoria. Le Homme Dieu is purer than Geneva, and Carlos is the purest of them all. Temperature of Lake Le Homme Dieu July 13th was 78° F. air 84°.

Lake Carlos

is the gem of this group of lakes. It is the last and lowest of the series. It is the immediate source of Long Prairie river, which forms its outlet at the northeast corner. It has two inlets, one from Lake Darling at the southern extremity, and the other from Lake L'Homme-Dieu. It thus receives the surplus waters of all the other lakes north and south and the drainage of six townships. The lake in some places is 150 feet deep, and there is a channel averaging about 50 feet deep, extending the entire length of the lake. The deepest area is not far from the L'Homme-Dieu inlet. There are shallow areas where the water is only 5 to 10 feet deep, further down the lake. It is about five miles long and a mile wide. The water is almost perfectly pure, of a deep bottle-green color. The color however varies with the sky and weather, and is sometimes a deep indigo and sometimes a light delicate blue. In this lake, as in many others which have been explored with the sounding line and other appliances for discovering what lies at the bottom, it was found that there are, under the level surface of the water, a variety of hill and dale, plateaus, ravines, abrupt declivities and gradual slopes very similar to the irregularities of the country around. Vegetation too flourishes beneath the waves as vigorously as on the main land, while the waters are thronged with fish of many species and of delicious flavor.

There are many indications about the shores of these lakes of former higher levels of water. There are old beaches and half-obscured terraces which show that the lakes were connected at no very remote date. The whole of "Alexandria prairie," which lies between the two chains of lakes, is modified drift. The gravels, sands and clays are finely stratified and record the fact that at the close of the ice age some ancient river with gentle current flowed here, rearranging and depositing in their present positions the materials which the glacier had brought down.

Lake Osakis.

On the eastern boundary of Douglas county, but lying chiefly in Todd county, is Lake Osakis. It is about seven miles long. The southern part is a mile and a half to two miles wide. The northern part is narrow and deep. The depths at the upper end of the lake varied from 40 to 70 feet. Near Battle point 50 feet of water were found repeatedly. In the broader part of the lake there are large areas of shallow water, varying from five to fifteen feet, the average depth being about twenty-five feet. Around the southern part of the lake, the prairie slopes down gradually to the water's edge. Some of the shores are low and wet. At other points they are from ten to twenty feet above the water. The water varies in purity. In the deep parts at the north end it was quite pure. In shallower places and where the mud stirs the whole volume to the bottom, it has the yellowish hue characteristic of the more alkaline lakes.

Lake Oscar.

Among the hills in the southwestern part of the county are a multitude of small lakes, the largest of which is Lake Oscar. The surrounding country is rolling, and there are some abrupt declivities and massive hills of drift, whose summits are from 50 to 150 feet above the lakes. There is a fringe of oaks about the lake, and a forest on the northeast stretches away to Alexandria and beyond. Toward the west and south lies a prairie country. The outlet of Lake Oscar, in high water, is into the Chippewa river. Its only tributaries are other and smaller lakes. The basin is subdivided by various points and bars. The outlet is very irregular. This interlocking of land and water gives the most charming scenery. The shores are bold, being in several places 30 to 40 feet above the water. The lake is about 30 feet deep in its largest basin, growing shallower, of course, about the shore's points. The temperature of water 75° F., and the air 58° F. to 80° F.

In the extreme northwestern part of the county is Lake Christina, which has an area of about six square miles, but is very shallow. The water is a decidedly yellow and muddy. It is full of reeds and rushes. Its shallow depths and the rills and runlets pouring down from clay deposits keep it looking very much like Missouri river water. It is rather exceptional in this respect among the lakes of this region. Pelican lake, which joins it on the southwest, is clear, although the lake also is shallow and the water clouded and alkaline. Neither of these lakes are attractive, although to one passing by on the railroad, which runs between them, they may appear so.

Otter Tail is the banner county of the State for lakes. It is said by those who have given their minds to counting them, that there are 430 lakes in the county. This number of lakes is not represented on any maps that I have seen. Still the number is sufficiently large, as any one will admit who has traveled over the county.

The relation of these lakes to the great moraine, that gigantic relic of the glacial age, which Mr. Upham has traced through the State, is both intimate and interesting. A glance at the map shows that the lakes occupy the central townships of the county. The eastern and western tiers of towns have none, or a few small lakes. This distribution of the lakes corresponds with the position and bearing of the moraines. Entering the county at the north, in the town of Hobart, the general direction of the drift deposit is southeast until, in the vicinity of Fergus Falls, it tends southeast and east, and then swings northeast, where its greatest development is seen in the "leaf nets," as they are popularly called. This hilly area is gemmed with lakes. Every depression in the rough and rolling ground holds a mirror to the sky and clouds. They are of all sizes, shapes and depths. Some have outlets, the largest ones especially: others have none, except in very high water; others have no outlet whatever at any time. Of some the water is whitish or clouded, holding in solution mineral substances derived from the clays and gravels of the shores. Others are apparently perfectly pure, colorless and sparkling.

It is manifestly impossible to examine all these lakes in a single season. Only those were selected which are typical or in some respects remarkable. Of the smaller lakes Lake Sewell in St. Olaf is as good a representative as any other.

Lake Sewell.

It is about two miles long and half a mile wide. The shores are not very high and generally slope gently to the water's edge. There is a fringe of trees and shrubs of the common species about the lake, but most of the country is massive rolling prairie with frequent lakelets and sloughs.

It was ascertained by sounding that the lake is 35 to 40 feet deep in the central or deeper parts. As there is no erosion of the banks the waters are quite pure and free from mineral substances. The bottom or floor of the lake is clay covered by gravel stones and the beaches are deposits of sand and pebbles.

In all these smaller lakes the same feature are repeated over and over. A large number of these lakes have no visible outlet except in very high water. The channel—of the outlet—is grass grown and dry, except a weeks or perhaps a few days in the year.

Lake Clitherall.

This beautiful sheet of water is nearly four miles long and one mile wide. It has a deep bay extending toward the south, a distance of two miles. The south shore is densely wooded and presents to the observer on the north side a very picturesque appearance. The shores at various points are bold and high, and there is a fringe of forest trees on the north side also, where the village of Clitherall, a Mormon settlement, stands. There are one or two bars extending nearly across the lake so that the water does not lie in one continuous basin. Our soundings gave for the east part of the lake a depth varying from 15 to 44 feet, and for the west part from 10 to 32 feet. The water is clear and had at the date of our visit, August 1, a temperature of 77° F. This lake lies at an elevation of 1332 feet above the sea. Its outlet is at the north-west side and discharges into West Battle Lake.

West Battle Lake.

This lake lies in two basins. The western half is nearly twice as wide as the eastern. The shores are in some places bold and abrupt, rising 40 to 60 feet above the lake. At other points the prairie slopes gently down to the water. There is not much forest. Nearly all the surrounding country, especially at the western extremity is cultivated prairie. The lake is over six miles long. The western part is about two miles wide; the eastern division about one mile wide. A high, wooded hill or promontory on the north side marks the line of division. Our soundings were made in the western part of the lake. The bottom of the lake is uneven. There are ridges and shallow places out some distance from the shore. We found repeatedly about 50 feet of water. The depths vary rapidly within short distances. The mass of the drift about these lakes is siliceous; some of these bluffs are almost pure sand; these crumble under the action of frost and weather and are distributed over the bottom of the lake by the waves. All the beaches are sand and pebbles. There is very little vegetation in the waters of this lake.

Owing to the purity of its water and the inequalities of depth, this lake presents the most rapid and beautiful play of colors. There is not a more charming or attractive spot in Minnesota than the vicinity of Battle lakes. They lie in midst of the famous Park Region, groves, lakes, cultivated farms, unoccupied woodland conspire to give variety and beauty to the scenery.

West Battle lake has two outlets, one from Lake Clitherall, the other from East Battle lake. Its outlet is on the north side and after passing through several smaller lakes, discharges into Otter Tail lake at Balmoral mills.

East Battle Lake.

The country around East Battle lake is very broken and hilly. The Leaf mountains lie a few miles to the southwest. Several small streams convey the drainage of these hills to the lakes. The basin of this lake is very irregular. There are numerous promontories, points and bays. The depth varies from twenty to forty feet. Only a small part of the lake was sounded, as no safe boat could be obtained. The hills and shores of the lake are covered with trees and shrubs. The outlet into West Battle lake has evidently run much wider and larger than now. It flows through a low meadow or swamp, and is still a considerable stream about ten feet wides.

On a high bluff between these lakes are a series of mounds which have the appearance of having been a fortified camp. Some of them are long and four to six feet wide. Others are nearly round. The largest round mound is about six feet high, 25 feet across the top, and 130 feet in circumference. There are about a dozen of the mounds together.

Otter Tail Lake.

This is the largest body of water in the county. Indeed in this whole lake district which embraces parts of Becker, Otter Tail, Douglass, Pope and Kandiyohi counties, there is no lake which can compare with this in size. It is about ten miles long and three miles wide. Its longest direction is from northeast to southwest. It has three inlets, one from the south and two from the north. The largest of these is known as Otter Tail creek and is the outlet of Rush lake. A large inlet also flows down from Dead lake on the north. At Balmoral mills on the south side it receives the surplus waters of the Battle lake chain. The soundings were in the southern central part of the lake going out from Balmoral mills. For distance of half a mile or more from the shore the water is quite shallow, only six to eighteen feet of water. Toward the centre of the lake it deepens to forty, fifty and sixty feet. This deeper area was followed for some distance toward the head of the lake, when the high wind prevented further measurements. The temperature of the water on the 30th of July was 74° F., air 78° F. Prof. Owen took the temperature of this lake on the 18th of June, and found it 65° F., air 64° F. The water is not perfectly pure. It has the yellowish or clouded color characteristic of shallow lakes with clay bottoms and shores. The soil on the southern side is sandy; at other points, however, the clay is exposed and the feeders are colored by the clay deposits through which they flow.

The lake is without islands or any bold and prominent indentations of the shore. It is therefore less picturesque and attractive than some other and smaller sheets of water. The outlet of Otter Tail lake is the Red River of the North, formerly known as the Otter Tail river. It is here 30 to 40 feet wide.

The southeastern shores of the lake are fringed with trees. Further north the prairie comes to the water's edge. On the western and northern shores are forests, interspersed with some fertile prairies or openings.

Dead Lake.

Northwest of Otter Tail, are several lakes of irregular shape, surrounded by forests and morainic hills and deposits of clay. Approaching Dead lake from the south, near its outlet, a fine growth of native forest trees is encountered. The sugar maple, basswood, oak, elm, ash and ironwood are especially noticeable. The lake itself is divided by bars and points, into several distinct basins and bays. The bottom is as irregular in shape as the shore line. The main body of the lake is shallow. Our soundings gave from 10 to 25 feet of water. There is a good growth of reeds, wild rice and other vegetation in the lake. There are a few small islands. The shores are full of boulders, both granite and limestone rock. It is indeed a lake of the woods, difficult of access, but wild and picturesque, a favorite haunt of water foul and other game. The principal tributary is a small stream which connects it with Star lake.

The country to the east is rough and hilly. One hill near the outlet rises abruptly 98 feet above the water. On the north side the shores slope more gently and smoothly to the water. Further still to the northwest is a chain of very beautiful lakes, lying on the west side of the great moraine and tributary to Pelican river. These are Lakes Lida and Lizzie and Pelican lake. Between these lakes and on the east side, there is a fine forest of hard-wood trees, of species already mentioned. On the west side the prairie stretches away toward the Red river. All the surrounding country is rolling and uneven. The largest of the three lakes is Lake Lida. It is about seven miles long and two miles wide. A narrower arm, about one mile wide, extends south from the main body of the lake for two miles. The eastern shore is wooded and hilly. The western shore is more level and the forest soon gives place to the prairie.

Between Lakes Lida and Lizzie, which formerly constituted one lake, there are several old beaches, now covered with forest trees, indicating that the former level of the lake was from seven to ten feet higher than it is at present.

The outlet of Lake Lida is at the north end. It is a strong current of water, three feet deep and fourteen feet wide. The temperature of the lake on the 13th of September was 63° F., air 70°. The lake varies in depth from 10 to 40 feet. About the shores it is shallow. The water is very pure and clear. There are several fine springs about the shores. There are, in the vicinity of these lakes, a number of cranberry marshes from which, without any effort at cultivation, a good many bushels of cranberries are gathered every year.

Lake Lizzie.

The southern part is quite shallow and narrow and filled with reeds and rushes for some distance out from the shore. The northern part is broader and deeper. The eastern shore is covered by forest, while on the western side the prairie, in some places, comes nearly to the lake. The country is massively rolling, and as a general rule sandy, but there are also large deposits of clay. One well, on the west side of this lake, was dug 78 feet, through sand and gravel, and another, a quarter of a mile away, 60 feet, through clay. The outlet of Lake Lizzie is the Pelican river, at this point 40 feet wide and 3 to 4 feet deep. About a mile west of the outlet the river spreads out into Prairie lake, which has an area of about two square miles. The quality and temperature of the water did not differ materially from that of Lake Lida. There are two small islands of about two acres each in this lake.

Pelican Lake.

This is a very picturesque and beautiful lake with high bold, high shores wooded on the eastern and prairie at the western end The water is very pure and sparkling. The depth varies from 8 to 40 feet. On the south side are some excellent springs. The ex posures of soil on lake shores are sandy: no clay was seen. The bottom is uery uneven, especially in the south arm, which is sometimes called Fish lake. From this arm the outlet discharges its waters into Lake Lizzie.

This country is not thickly settled. A large amount of land is still unclaimed. The tide of emigration has swept into the more fertile and better advertised Red River Valley.

These three lakes with seven or eight others in Becker county, which lie above them, constitute the Pelican chain and are a grand reservoir of water feeding that river with perpetually fresh supplies.

IX.

REPORT OF PROGRESS

IN EXPLORATION OF THE

GLACIAL DRIFT AND ITS TERMINAL MORAINES.

BY WARREN UPHAM.

The work of exploration during 1880, of which the following is a partial report, was begun on the 19th day of April and closed on the 3d of December, the distance traveled by horse and wagon in this time being about 4,500 miles. Excepting a trip of six weeks between the St. Croix and Mississippi rivers and through the south part of Stearns county, to a north limit in Pine, Kanabec, Mille Lacs and Crow Wing counties, the remainder of this year was spent in the examination of the region lying south of the Minnesota river, to an east limit in Dakota, Rice, Steele and Freeborn counties. These districts have been explored in respect to their topography, economic geology, glacial drift, and their few exposures of the older rocks. Information has also been gathered concerning the flora, areas of forest and prairie, and water-powers.

New observations of rocks underlying the drift include a Cretaceous sandstone seen in Altavista, the northeast township of Lincoln county, at a few points in northwestern Lyon county, and at one place in Martin county: an area of the red Potsdam quartzyte, extending 22 miles from east to west in northern Cottonwood county, and reaching into the edge of Adrian, the northwest township of Watonwan county, and of Stately, the southwest township of Brown county: and several outcrops of granite, gneiss and schists, occurring 10 to 20 miles southwest of the Minnesota river, in Yellow Medicine and Redwood counties. Records have been secured of the strata passed through by deep wells at Hastings, Mendota, Owatonna and Mankato, the last being 2,204 feet deep, not penetrating the Potsdam formation; and of several wells which go through the drift and a small depth into the bed-rock, in Waseca, Freeborn and Faribault counties, which have no outcrops of rocks on the surface.

Additions have also been made to our knowledge of the Lower Silurian rocks exposed on the Blue Earth river and its tributaries; of the Potsdam quartzyte in Pipestone and Rock counties, and in Minnehaha county, lying at the west side of the latter, in Dakota; of the St. Croix sandstone and copper-bearing rocks at the east side of the State; and of the outcrops of syenite, granite and gneiss in Benton and Stearns counties; most of which Professor Winchell has examined and in part described in the earlier reports of this survey.

Four counties, namely, Steele, Freeborn, Pipestone and Rock, which had been previously reported on, were again explored with special reference to the glacial drift; and notes were gathered for the general description of the following seventeen counties: Chisago, Isanti, Waseca, Faribault, Blue Earth, Brown, Watonwan, Martin, Jackson, Cottonwood, Redwood, Lyon, Murray, Nobles, Lincoln, Yellow Medicine and Lac qui Parle.

Nine of these twenty-one counties have no exposure of the bed-rocks, and the greater part of each of the others is without such outcrops. Our observations therefore relate chiefly to the superficial deposits of drift, and of these the portions which have added most to our knowledge of the succession of events in geological history, are the ranges of drift hills denominated terminal moraines. A remarkable formation of this class has been traced in an irregular, looped course through Minnesota. Our exploration has also been extended southward into Iowa, in order to learn whether the two parts of this series which reach beyond the south line of the State are connected by a continuous, curving belt, being thus shown to have been formed at the same epoch. The present report treats principally of this formation, which is believed to have been accumulated at the margin of a vast ice-sheet that overspread the northern half of North America in the latest completed period of geological time, as the Antarctic continent and the interior of Greenland are now buried beneath ice thousands of feet deep.

THE GLACIAL DRIFT.

The region covered by this exploration, like that lying next to the north, traversed by the writer in 1879, and described in that year's report, is thickly overspread by the glacial drift, with very rare exposures of the bed-rocks, except in deeply-excavated valleys, as of the Minnesota river. Along this river the drift-sheet is from 100 to 200 feet thick, and it extends with a similar depth over the western two-thirds of Minnesota and over large areas in Michigan, Wisconsin, Iowa, Dakota and the region farther northwest drained by the Assiniboine and Saskatchewan rivers.

Within the portion of Minnesota explored during these two years, the material of this thick sheet of drift nearly everywhere is the unmodified deposit of the ice-sheet, composed of clay, sand, gravel and boulders, mixed indiscriminately in an unstratified mass. Very finely pulverized rock, forming a stiff, compact, unctuous clay, is its principal ingredient, whether at great depths or at the surface. This formation is denominated till, boulder-clay or hardpan. Layers of stratified gravel and sand are enclosed in this deposit, and are the source of the sudden inflow and rise of water frequently found in digging wells.

The till upon the western two-thirds of this State has a dark blueish color, except in its upper portion, which is yellowish to a depth that varies from 5 to 50 feet, but is most commonly between 15 and 30 feet. This difference of color is due to the influence of air and water upon the iron contained in this deposit, changing it in the upper part of the till from the protoxide state to hydrated sesquioxide. Another important difference in this till is that its upper portion is more commonly softer and easily dug, while below there is a sudden change to a hard and compact deposit, which must be picked, and is often three times as expensive for excavating. There is frequently a thin layer of sand or gravel between these kinds of till, which have their division line at a depth that varies from 5 to 30 or very rarely 40 feet. Owing to the more compact and impervious character of the lower till, the change to a yellow color is usually limited to the upper till. The probable cause of this difference in hardness was the pressure of the vast weight of the ice-sheet upon the lower till, while the upper till was contained in the ice and dropped loosely at its melting.

The motion of the ice-sheet upon this part of the State was from the north to the south or southeast, as is shown by the direction in which the boulders of the drift in this region have been carried, and by the courses of glacial striæ, or the scratches and grooves worn on the surface of the bed-rock by stones and boulders pushed along in the ice. Most of the limestone boulders and blocks that occur frequently in the drift throughout western Minnesota, are like limestone strata which are found in Manitoba; these are their nearest outcrops, but they may underlie the drift in portions of western and northwestern Minnesota. The boulders of granite, syenite, gneiss and schist, which abound here and southward through Iowa to the limit of the drift in Missouri, have been derived from the Laurentian highlands north of Lake Superior, and from the broad area of these rocks which reaches southwestward across Minnesota to the Coteau des Prairies. The masses of copper that are found rarely in the drift of southern Minnesota and Iowa, west of the driftless area, were almost certainly brought from the vicinity of Lake Superior, and demonstrate that the current of the ice-sheet by which they were carried was first southwest and then south. Outcrops of the red Potsdam quartzyte are found at various places from New Ulm west-southwest to the James river. North from this district the drift contains no boulders of this rock, but southward they are common; and though this formation extends into Iowa only at its northwest corner, its fragments have been spread by the ice-current through the till of that State west of the Des Moines river and its east branch, but not farther east.

Everywhere a great part of the material of the drift has been supplied by the rocks which form the region adjoining, in the direction from which the ice-current came. Boulders and pebbles of any peculiar kind of rock which can be referred to a particular source, are most abundant within the first ten or twenty miles from their parent ledges; and they diminish in numbers and average size as the distance from their source increases. While the drift is always made up largely in this manner from the formations of its vicinity, some parts of its mass, including both fine detritus and boulders, were gathered at great distances. Fragments of Laurentian rocks in the till south and west of Minnesota, appear to have been carried by the ice-sheet from 500 to 700 miles.

Upon the district lying between the St. Croix and Mississippi rivers, along the St. Louis river to its bend in T. 51, R. 20, and on both sides of Lake Superior, the till is reddish, its color sometimes being nearly like that of red brick. Generally, also, the stratified gravel, sand and clay of this region are similarly colored. Eastward these red drift deposits extend through northern Wisconsin and the upper peninsula of Michigan and southward into central and southern Wisconsin at the east side of the driftless area. The color of this drift is caused, as Col. Charles Whittlesey has suggested[*], by the presence of a considerable portion of hematite, the anhydrous sesquioxide of iron, derived from the large areas north and south of Lake Superior, which are occupied by rocks bearing this ore. Boulders within this region have been transported from the northeast to the southwest and south; and the courses of glacial striæ are in these directions. The red till in eastern Minnesota was thus deposited by a part of the ice-sheet which came from Lake Superior, and extended southwestward to a limit that coincides approximately with the course of the Mississippi from Brainerd to Hastings; while in other parts of the State, blue till, colored yellowish near the surface, was formed by a part of the ice-sheet which moved from the northwest and north.

The terminal moraines which form the principal subject of this report, show that the southern portion of the continental ice-sheet was divided into great lobes, each having a central current in the direction of its longer axis, with diverging currents bending from this and becoming perpendicular to its border. The red and blue tills were the deposits of two such ice-lobes which overspread Minnesota from the northeast and northwest. During the most severe epoch of the ice age, before that in which the terminal moraines of Minnesota were accumulated, an ice-sheet reached much farther south, to a limit 20 to 100 miles southwest and south of the Missouri river and within a less distance north of the Ohio river. Portions of this glacial sheet, moving from the northeast, north, and northwest, enclosed an area about 150 miles long from north to south and 100 miles wide, lying principally in southwestern Wisconsin, but extending into Illinois, Iowa and southeastern Minnesota, which was not covered by ice and has no till nor striæ. This driftless area has a less average height than the adjoining regions which were glaciated. Climatic conditions of greater snowfall and lower temperature seem to have produced the ice-fields, which lay at each side of this tract and were confluent farther south.[†] The wedge-shaped area of highland that reaches southwest from Keweenaw Point, at the south side of Lake Superior, and the depressions of Lake Michigan and Lake Superior, have also been regarded as the causes of this division of the continental glacier.[‡]

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[*] On the Fresh-water Glacial Drift of the Northwestern States, in Smithsonian Contributions, 1864, pp. 8 and 9.

[†] Prof. J. D. Dana, in Am. Jour. Sci., April, 1878; Third series, vol. xv., pp. 250—255

[‡] Prof. N. H. Winchell, in fifth An. Rep. on Geol. Sur. of Minn., 1876, pp. 36 and 37; and Prof. R. D. Irving, in Geology of Wisconsin, vol. ii, 1877.

The occurrence of this driftless tract shows that the ice-sheet which reaches farthest south was divided in portions that moved independently, with diverging and converging currents; and that in respect to the districts over which they extended, these glacial movements corresponded to the lobes that formed the southern part of the ice-sheet at the later time when the looped moraines of Wisconsin, Minnesota, Iowa and Dakota were pushed out at its margin.

The red and blue tills were being deposited during each of these epochs, and where the blue overlaps the red, as in Hennepin county, both may have been formed while the ice-sheet reached to its farthest limit, covering all this region excepting the driftless area at the southeast. Differences in climate, intervening between the early and late portions of this epoch, would then appear to have extended the ice-fields on the west, pushing back the glacial current which came from the northeast, by which the red drift was brought. The later ice-sheet which formed our terminal moraines was here divided into lobes that similarly advanced from the northwest and northeast, approaching near each other at the west and east borders of Minneapolis, and meeting in northern Dakota county, a few miles farther south. At this time the ice-fields moving from the northwest extended here at least several miles eastward over the edge of the earlier sheet of red till; and it may be found, by more full and detailed study of the terminal moraines through this part of the State, that all the blue till overlying the edge of the red till was brought during this last glacial epoch, in which a new deposit of red drift was also spread over eastern Minnesota to the moraine that was then formed by the ice-fields moving from the northeast.

TERMINAL MORAINES.

Within the last five years a very important contribution to our knowledge of the ice age has been made in the discovery of distinct series of drift-hills which appear to have been accumulated at the margin of the continental ice-sheet, corresponding to the terminal moraines of alpine glaciers. The most notable of these deposits which have been found at the extreme limit of glacial action is the series of drift-hills which has been explored by Professors Cook and Smock across northern New Jersey,* and by the writer through the entire length of Long Island, and on Block

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**Annual Report of the State Geologist for the year* 1877, pp. 9-22, with map.

Island, Martha's Vineyard and Nantucket.* Five to thirty miles north of this line a second morainic series extends from Port Jefferson eastward along the north shore of Long Island, through Plum and Fisher's islands, along the south shore of Rhode Island, forms the chain of the Elizabeth islands, and reaches along Cape Cod to its east shore.† In Pennsylvania the continuation of these moraines westward is now being traced by the second geological survey of that State. The extreme limit of the glacial drift has not yet been found to be marked by extraordinary deposits in the interior of the United States; but a most notable series of terminal moraines, north of this line and probably contemporaneous with that of Cape Cod, is found, as shown by Professor Chamberlin,‡ stretching across Ohio, and represented in northern Indiana, southern Michigan, northeastern Illinois, and very remarkably in the Kettle Moraine of Wisconsin.§

Plate VI., at the end of this report, shows the course of this formation from central Wisconsin to the Coteau du Missouri, the direction of glacial movements, and the driftless area. In Wisconsin this follows the descriptions and maps of the geological survey by Professors Chamberlin and Irving. The terminal moraine marking the limit of the ice-fields which pushed southwestward from Lake Superior in our last glacial epoch, continuous with the Kettle Moraine of Wisconsin, enters Minnesota at the west side of St. Croix lake, is crossed twice by the Mississippi, 7 to 10 miles south of St. Paul, and again between this city and Fort Snelling, and reaches thence northward between Saint Paul and Minneapolis, to the hills of Manomin and Mound View. Its course thence north and northwest to the Leaf hills has not yet been fully explored. The plan for the field-work of 1881 covers this district and the valley of the Red river, which was occupied by the glacial Lake Agassiz during the recession of the ice-sheet, as partially described in my preliminary report for 1879. That report also described this terminal moraine in its course from the Leaf hills in southern Otter Tail county, southward through Douglas and Pope counties, eastward through Kandiyohi, Meeker and Wright counties, and again southward through Hennepin, Scott, Rice and Le Sueur counties; showing that this series of drift hills, extending 250 miles, if we include also the medial moraine that continues 50 miles north from the Leaf hills to White Earth Agency, was accumulated at the northeast side of a prolonged lobe of the ice-sheet which reached from the Leaf hills southward into Iowa, having its west side at the Coteau des Prairies.

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* *American Journal of Science and Arts*, Aug. and Sept., 1879; Third series, vol. xviii.

† *American Naturalist*, Aug. and Sept., 1879; vol. xiii.

‡ "On the Extent and Significance of the Wisconsin Kettle Moraine," in *Transactions of the Wisconsin Academy of Science*, 1878, with maps.

§ *Geology of Wisconsin*, vol. ii., 1877; and vol. iii., 1880.

The exploration of this terminal moraine in 1880, as detailed in the following pages, continues from the limit of the preceding year, at the south side of Rice and Le Sueur counties, through Steele, Waseca and Freeborn counties, and into Iowa to Mineral Ridge in northern Boone county, a distance southward of 140 miles; and reaches along the west side of the U-shaped course of this formation from the north part of Guthrie county, in Iowa, to Spirit lake and northeastern Osceola county at the north line of the State, across southwestern Minnesota upon the Coteau des Prairies, and into Dakota to t. 119, r. 50, in Grant county, 20 miles southwest of Big Stone lake, a distance of 260 miles; making, upon both sides of this morainic loop, a total of 400 miles. The moraine described by Dr. C. A. White,* in Hancock and Kossuth counties, Iowa, at first supposed to mark the southern end of the ice-lobe at the border of which this curved series of hilly and knolly drift was accumulated, appears instead to be a medial moraine, connected with the east side of this loop which reaches southward beyond the center of Iowa.

Beyond the western limit of this exploration in Dakota, our map is based on the various authorities which are cited in the description of the apparently medial moraine which reaches from the Head of the Coteau des Prairies, west of Lake Traverse, 275 miles northwesterly to the Devil's lake and Turtle mountain, and of the looped terminal moraine which extends south at the west side of the Big Sioux river, then west across the lower part of the James river and northwest upon the Coteau du Missouri. The features of these moraines upon our national boundary at Turtle mountain and at the northwest corner of Dakota, the latter being outside the area of this map, are from Mr. George M. Dawson, of the Geological Survey of Canada. Still farther north the continuation of the moraine of the Coteau du Missouri is briefly described from the writings of the same author, and from the report of Prof. H. Y. Hind on explorations in the region of the Assiniboine and the South and North Saskatchewan rivers.

Professor Hind also gives an account of channels that have been deeply excavated in the glacial drift, and have since become partially filled, so that the present streams flow through long lakes. The most remarkable of these channels or valleys is that which reaches from the elbow of the South Saskatchewan to the Assiniboine river, being occupied by the River that Turns and the Qu'Appelle or Calling river. Gen. G. K. Warren has called attention* to the similarity of these valleys with that which was the outlet of Lake Agassiz and now contains Lakes Traverse and Big Stone and the Minnesota river. The formation of the valleys described by Professor Hind may be well referred to causes like that which is believed by the writer to have formed the Minnesota valley, namely, the existence of lakes within basins which slope to the north or northeast, held by the barrier of the ice-sheet during its recession northward at the close of the glacial period, and outflowing over the present lines of watershed until the departure of the ice permitted drainage to take place as now. By applying this explanation to the ancient channels which evidently have carried large rivers southeastward over the watersheds of the basins of the South Saskatchewan and Souris rivers, we are enabled to note the successive steps by which the ice-sheet retreated. After it had been melted away upon Dakota and nearly to the north line of Minnesota, it appears to have re-advanced, forming the apparently contemporaneous terminal moraines of the Blue hills and the Mesabi range, the former reaching 75 miles east from the lower part of the Souris or Mouse river, and the latter extending through northern Minnesota eastward from the sources of the Mississippi. Lake Agassiz filled the depression which lies between these morainic series, concealing the coarser drift beneath its stratified sand and clay.

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*Geology of Iowa, 1870, vol. i., pp. 98 and 99.

The material of the terminal and medial moraines which have been explored during 1879 and 1880, extending 650 miles, is nearly everywhere till, or chiefly till with scanty deposits of modified drift. The latter consists of obliquely and irregularly stratified gravel and sand, the gravel often being very coarse, with pebbles and rounded stones of all sizes up to a foot or more in diameter. It either occurs enclosed in the till, forming beds and masses of variable shapes from a few inches to several feet in thickness, or rarely it is spread upon the surface and forms knolls and ridges. No considerable area or large portion of the entire mass of this formation is found to consist of this modified drift, assorted and deposited in layers by currents of water, within this region; but in some parts of the course of these series of terminal drift deposits, as notably on Long Island, they are made up wholly, so far as can be seen on the surface and in excavations, of such stratified beds. The till of the moraines differs very noticeably from the more level areas of till which generally lie at each side; in that the former has many more boulders, and a much larger intermixture of gravel and sand than the latter. On an average, probably twenty times as many rock-fragments, both large and small, occur in the morainic hills and knolls as on the smoother tracts, and sometimes the ratio is a hundredfold. The smaller pebbles and stones have angular and unworn forms, or more frequently are rounded, probably by water-wearing before the glacial period, or show planed and striated surfaces, due to grinding under the moving ice-sheet. The large boulders are mostly less than five feet, but rarely are ten feet or more in diameter. In form they are subangular and of irregular shape, rarely showing any distinctly water-worn or glaciated surface.

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*An Essay concerning Important Physical Features exhibited in the Valley of the Minnesota River and upon their Signification. Engr. Dept., U. S. Army: 1874.

In contour these deposits are very uneven, consisting usually of many hillocks, mounds and ridges of rough outlines and broken slopes with enclosed hollows, which are sometimes nearly round, but more generally have some irregular form. often holding sloughs and lakelets. The only indication of system appears in the frequently noticeable trends of the elevations and depressions in a direction approximately parallel with the course of the series. It should be added that the ridges which occur as part of this formation differ from the ridges of interbedded gravel and sand called kames, in their material, which is boulder-clay or till; in their trend, at right angles with the course in which the ice moved, while series of kames extend nearly in the direction taken by glacial currents; and in their length, single ridges of the moraines being only from a few rods to a quarter of a mile or very rarely perhaps a half mile long, while a single ridge in a series of kames is generally longer, and is sometimes distinctly traceable ten or twenty miles. In this State, however, prolonged kames, comparable with those of Sweden and Scotland, and those recently described in Maine by Prof. George H. Stone, in Massachusetts by Rev. G. F. Wright, and in New Hampshire by the writer, have not been found. Besides the very rough, knolly and ridgy portions of moraines, in some other districts within the extent of these explorations they have only a prominently rolling surface, moulded in smooth swells of moderately steep and gracefully curved slopes, also trending, wherever any uniformity is noticeable in the direction of the series. Neither these nor any other drift accumulations observed in this region have the smoothly oval contour of the remarkable lenticular hills of till described by Prof. C. H.

Hitchcock and other writers in New England; and the trends of these two classes of drift hills differ ninety degrees in their relation to the course of motion of the ice-sheet.

The height of the moraine elevation above the intervening hollows is generally from 25 to 75 or 100 feet. The only district where they are higher for any considerable part of the series is the Leaf hills, which through a distance of 20 miles rise from 100 to 350 feet above the adjoining country. Upon the Coteau of the Prairies and the Coteau of the Missouri moraines lie on areas of highland, to the altitude of which they appear to add 75 or 100 and rarely 150 or 200 feet.

For agriculture the value of these terminal and medial moraines is much less than that of the gently undulating till which generally covers other parts of this region. Among the hills of this formation, however, are found considerable areas which have a smooth surface, nearly free from boulders, and possess a highly productive soil. In other districts the entire morainic belt is in smooth swells, being all good farming land. The portions which are too knolly and stony for desirable cultivation afford excellent pasturage; for the greater part of this formation like the region through which it extends. is prairie, or natural grass lands, without tree or bush. Its rough and hilly belts occupy at the most, only a width of a few miles, and nowhere merit the description which Owen, usually a very accurate observer, gave of them in northern Iowa, where he reported that "a desolate, barren, knobby country. .... prevails for about three quarters of a degree of latitude, and between three and four degrees of longitude, embracing the watershed where the northern branches of the Red Cedar and Iowa, and the eastern branches of the Des Moines, take their rise."* The southward continuation of the Minnesota moraines has been traced by the writer, as hereafter described, through this district, which is found with the exception of narrow belts, to be like nearly all the region explored during these two years, very productive and easily cultivated land.

Among the principal additions to our knowledge of the glacial period afforded by the explorations here reported, we may place, first, the occurrence of two well marked morainic series, composed of hilly and knolly drift, each a few miles in width, divided by a belt of smoother surface, from two or three to twenty-five miles wide, extending through nearly this entire distance of 400 miles. This is found to be the character of the deposits accumulated both at the east and west borders of the ice-lobe, which reached southward from Minnesota to central Iowa. In Yellow Medicine and Lac qui Parle counties a third morainic range extends through a distance of forty miles, and is continued beyond in Dakota. As the course of the formation makes a loop like the letter U, having been accumulated by ice-fields covering the district enclosed, the outer moraine on each side is known to have been first made; then, after a retreat of the ice-sheet, probably followed by a re-advance, the inner moraine was formed; and, lastly, the third range, which lies still farther within this area; for the inner series would have lost their roughly knolly and hilly contour, if they had been covered by a moving ice-sheet, forming terminal deposits beyond them. Since the observation of this twofold, and in part threefold character of this formation, the writer finds that Professor Chamberlin records it as similarly exhibiting three distinct morainic belts, divided by smoother tracts, in a section between Black Brook (T. 32, R. 16) and St. Croix Falls, at the west side of Wisconsin.*

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*Report of a Geological Survey of Wisconsin, Iowa and Minnesota, 1852; Introduction, pp. xxxv and xxxvi.

A second observation of much importance is that the abundance of lakes which dot the map of Minnesota and northern Iowa, extends only to the outer line of the moraine here described, which appears to have been accumulated at the border of the ice-sheet in our last glacial epoch. In southeastern Minnesota the glacial drift reaches fifty miles farther east to the driftless area, and in southwestern Minnesota covers Pipestone and Rock counties, beyond this moraine; but within these districts, and upon the large area in eastern and southern Iowa, and in northern Minnesota, which are covered by drift, lakes are very rare, and none of any considerable size exist. Professor Chamberlin has also noted the same presence of many lakes along the belt of the Kettle Moraine and northward in Wisconsin, and their absence from the region southward. As to what this remarkable difference teaches concerning the relative age of the drift upon these areas, or the conditions attending the earlier epoch, when an ice-sheet extended much farther south, we are not yet prepared to express an opinion.

Another point to which we wish to call the attention of glacialists is the great length, in proportion to the width, of the ice-lobe which accumulated at its east and west sides the looped moraine that reaches, in nearly parallel belts, from the Leaf hills 400 miles, and from the Head of the Coteau des Prairies 300 miles, south-

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*Geology of Wisconsin, Vol. III., 1880; pp. 384 and 385.

southeast to central Iowa. The distance between the exterior limits of these belts, which measures the width of this ice-lobe at its greatest extent, is from 85 to 125 miles. If we compare this with its length, and consider the approximating local and uniform character of the district covered by the ice, and the areas at each side which it did not cover, it seems to be a necessary conclusion that this prolongation of the ice-sheet beyond the great expanse which it wholly covered farther north, was due principally to greater snowfall and colder temperature upon the district occupied by this ice-lobe, than on the adjoining areas at the east and west. Some portion of these ice-fields was doubtless supplied by a glacial current from the north, but the greater part was apparently the result of local climatic conditions. The maps accompanying Professor Dana's article on the causes of the driftless area, already referred to, indicate that, the present aqueous precipitation upon these districts continuing unchanged, a very cold climate would be likely to produce an ice-sheet lobed like that of our last glacial epoch; and that, with increased cold, it might extend farther south, enclosing an area not covered by ice.

The origin of the series of drift hills here described is confidently referred to the action of the continental ice-sheet, accumulating then at its margin and in medial lines within the ice-covered areas where converging glacial currents were pushed together. This conclusion is required by the partly near and partly remote sources of their material; by its generally unstratified condition; by its transportation next to these hill-ranges in courses nearly at right angles toward them, and by the variable elevation of the series, conforming to all the irregularities in altitude of the region across which it extends. Tables of heights, determined by railroad surveys within this region, and a list of elevations of these moraines, are placed at the close of this essay.

Directions in which glacial currents moved are shown on the map by arrows and dotted lines, which in this State represent the observations recorded in the following table.

Courses of Glacial Striæ in Minnesota,

Referred to the true meridian.

North shore of Lake Superior (Norwood and Whittlesey)	S. 25°—45° W.
Vermilion lake (Whittlesey)	S. 15° W.
Rainy lake (Whittlesey)	S. 40°—60° W.
Lake of the Woods (G. M. Dawson)	mostly S. W.

Duluth	W. S. W.
Hinckley, Pine county	S. 5° W.
Watab, Benton county	S. 15° W.
St. Croix Falls (Chamberlin)	S. 35° E.
Minneapolis, Nicollet island	S. 5° E.
Minneapolis, Hennepin island	S. 22° E.
Minneapolis, quarry opp. University	S. 12° E.
Big Stone lake	S. E.
Granite Falls	S. 45°—50° E.
Beaver Falls	S. 60° E.
Fort Ridgely	S. 60° E.
Redstone, near New Ulm	S. 25° E.
Jordan	S. E.
Posen, Yellow Medicine county	S. 50° E.
Echo, Yellow Medicine county	S. 50°—55° E.
T. 111, R. 38, Redwood county	S. 50°—60° E.
Stately, Brown county	S. 50°—55° E.
Germantown, Cottonwood county	S. 30° E. and S. 70° E.
Dale, Cottonwood county	S. 20°—35° E.
Amboy, Cottonwood county	S. 35°—70° E.
Delton, Cottonwood county	S. 15°—80° E.
Selma, Cottonwood county	S. 18°—22° E.
Adrian, Watonwan county	S. 20°—30° E.
Pipestone quarry	S. 20°—30° W.
Mound, Rock county	S. 25°—35° W.
1½ miles N. W. from last	S. and S. 35° W.
Northwest corner of Iowa (White)	S. —S. 8° E.

THE TERMINAL MORAINE IN STEELE, WASECA AND FREEBORN COUNTIES.

South from Faribault to the Iowa line this formation consists of two belts of knolly and hilly till, from one to several miles in width, extending from north to south, divided by a tract of gently undulating till, from six to fifteen miles wide. In Steele county the eastern or outer morainic belt extends through Merton, Havana, Aurora and Blooming Prairie, its eastern range of townships. It occupies the greater part of Merton, at the northeast corner of this county; but its hillocks, mounds or swells are only from 20 to 30 and rarely 40 feet high. Most of them consist of till, or drift clay, enclosing boulders; but here and there are mounds of irregularly stratified fine gravel and sand. The east third of Havana has a similar rolling surface, bordering the west part of Rice lake. Through Aurora this moraine is well exhibited in scattered mounds and hillocks, 15 to 40 feet high. On the road from Owatonna to Blooming Prairie and Austin, it is crossed in sections 9, 15 and 22, being here about three miles wide. At Aurora station, and for 1½ miles south, this formation is finely seen at the east side of the railroad, by which it is crossed in section 28. The boundaries of the moraine are very definite in this township. Its narrowest place in the county is found in section 28, north of which it is indented on its northwest side by a tract of lowland and marsh, which lies next west of the railroad, reducing the width of the hilly tract to one mile. At the west and southwest this quickly widens again to two or three miles, covering sections 29, 30, 31 and 32, of Aurora, and sections 25 and 36 of Somerset, with a profusion of knolls and hills, 20 to 50 feet high, sprinkled with boulders, principally granite and gneiss, mostly less than two feet in diameter, with occasional blocks or slabs of limestone, sometimes 6 or 8 feet long. These elevations are seldon prolonged more than a few hundred feet. The trend of their large axis is more frequently from east to west than otherwise, but this is not very noticeable. From the southeast corner of Somerset the moraine turns southward, and extends in typical hills and short ridges through the west two ranges of sections in Blooming Prairie. Here the trend of its separate elevation is most frequently from north to south, being parallel, as before, in its east to west trends, with the course of the whole series. In the west part of sections 8 and 17, Blooming Prairie these rough hillocks are well exhibited, being 20 to 50 feet above the depressions, and 75 or 100 feet above the neighboring creek.

This eastern belt of drift hills and knolls in Freeborn county is from a half mile to one and a half miles wide. It extends south, through Newry, Moscow and Oakland, in the east range of townships of this county, and next passes southwest through the southeast corner of Hayward and the center of Shell Rock, the two southern townships of the range next west. More exactly, its course in Newry is through sections 5, 9, 16, 21, 28 and 33, and in Moscow through sections 4, 9, 16, 20, 30 and 31. The roughest of this series in Freeborn county is in the school section 16, in Newry, where it presents the typical morainic contour in abundant small hills, short ridges, mounds and hollows through and over which a road extends from north to south. In Oakland and Shell Rock this morainic belt forms the water shed between the Cedar and Shell Rock rivers. Its course is through sections 6, 7, 17, and the east part of 18, 19 and 30, Shell Rock. This range is generally 25 to 50 feet above the smooth and nearly level or gently undulating till on each side.

The western or inner moraine lies in eastern Waseca county, and in the southwest edge of Steele county, and extends from north to south in Freeborn county by Albert Lea. The width of this morainic belt varies from three to ten or twelve miles. Its hills are almost universally till or unmodified glacial drift, rising in smoothed but variable slopes, and exhibiting no parallelism or system in their trends. From Okaman, at the north line of Waseca county, southeastward through the northeast part of Iosca and in the southwest corner of Blooming Grove, two miles north of Waseca, these elevations are 30 to 50 feet high. Through Woodsville, within two to four miles east and southeast from Waseca, inconspicuous scattered drift hills and mounds, constituting a generally rolling surface, represent the morainic series. In Otisco, the next township south, it rises to its usual prominence in section 5, one and a half miles east of Wilton, where we find numerous steep ridges and round or irregular hills, more strewn with boulders than the other portions of this township, which are moderately rolling and occasionally hilly. The east two ranges of sections in New Richland are mainly covered by morainic mounds, swells and hills, 30 to 50 feet above the intervening hollows. In Steele county this formation occupies the northwest part of Meriden and the western two-thirds of Lemond and Berlin townships, being here made up of massive swells of smooth contour, 20 to 40 feet above the frequent depressions, many of which contain sloughs. The east portion of this rolling land is three or four miles west of Straight river. The greater part of the basin of the Shell Rock river in Freeborn county is included in this morainic belt, which expands to a breadth of 8 to 12 miles. In range 21, this includes Bath, Bancroft and Albert Lea townships, and the northwest half of Freeman, in range 22, the southeast third of Hartland, Manchester, except its west margin, Pickerel lake, exepting sections 6, 7, and part of 18, and Nunda, and in range 23, the southeast corner of Alden, and Mansfield, the southwest township of the county. In Mansfield these drift hills enclose a large plain of modified drift which extends five miles west from Bear lake. The hills of this belt are mostly rather smooth swells of gracefully rounded outlines, but often with steeply sloping sides. No prevailing trend is noticeable. Their most conspicuous developement is found about three miles west-northwest from Albert Lea, being within a mile westward from White lake in sections 1 and 2 of Pickerel lake township. Here their crests are from 75 to 100 feet above the hollows; and in other parts of this county they are generally from 40 to 60 feet high.

Prominent drift hills which occur in Kiester, the southeastern township of Faribault county, are so closely connected with this moraine in southwestern Freeborn county, that they appear to be a part of the same belt, and are probably a terminal deposit of the ice-sheet. If so, these hills show that near the close of this glacial epoch the ice-margin here became indented by a re-entrant angle, between the two confluent ice-currents by which the medial moraine that reaches northwest across this county was formed. The most hilly portions of Kiester are its south side for a width of one mile, and a belt through its northeast portion from sec. 13 to secs. 3 and 4. The last mentioned hills are the most conspicuous of this region, and are visible fifteen miles to the north and west. Their height is from 100 to 200 feet above the lowland in these directions and above Bear lake in Freeborn county; the highest points, which are in the southwest quarter of section three, being about 1400 feet above the sea. These are massive hills of till, of irregular outlines, but trending somewhat more from east to west than in other directions.

Northwest from the Kiester hills, a belt of hilly or more or less rolling land, believed to be contemporaneous in origin with the foregoing, and formed as a medial moraine by conveying ice-currents reaches twenty miles to the southwest part of Lura; and ten miles beyond appears to be represented by a hilly and rolling tract in the northwest part of Sterling, in Blue Earth county. In Foster, the township next north of Kiester, it is boldly rolling in hills of till 50 to 75 feet high, from section 28 north and northwest by Rice Lake, where it extends with a width from one-half mile to one mile at each side of the lake. Still farther northwest the same contour and material border the east, north and west sides of Walnut lake, including the most of sections 25 to 28 and 33 to 36, of Walnut lake township. In sections 16 and 8, 2½ to 5 miles northwest from this lake, is an area of swells, knolls, and northwest to southeast ridges, 30 to 40 feet high, of very gentle slopes, composed mainly of stratified sand and fine gravel, as shown by wells, which do not penetrate these deposits of modified drift at the depth of 50 feet. In Barber, the township next west, a prominently rolling tract is found about the little lakes in sections 14, 15, 22 and 25. The material here is till, and its swells or hills are 30 to 50 feet above the hollows. Through six miles thence northwest a more or less rolling surface of the unmodified glacial drift continues in a belt about two miles wide, to the south-west part of Lura and the east edge of Delavan. This morainic belt divides two extensive areas of till, which are characterized by a very smooth, flat surface.

EXPLORATION OF THE TERMINAL MORAINE IN IOWA.

The course and general character of this formation in its continuation from Freeborn county southward into Iowa, have been explored through portions of Worth and Winnebago counties, Cerro Gordo and Hancock, Franklin and Wright, Hardin and Hamilton, Story and Boone counties, to Mineral Ridge in northern Boone county, 90 miles south of the Minnesota line. Through the north half of this distance it continues in two belts of hilly and knolly or rolling till, from one to five miles in width extending approximately from north to south, nearly parallel with each other, and divided by a tract of slightly or moderately undulating till, 5 to 15 miles wide. At the northeast corner of Hancock county, these belts are united by a notably morainic area, three or four miles in width, lying at the north side of Lime creek, and culminating in Pilot Mound, which is about 200 feet high, being the most prominent hill found in the whole extent of this moraine in Iowa. Westward from Pilot Mound, a typically morainic belt, varying from one half mile to three miles in width, extends in northern Hancock county along the north side of Lime and Silver creeks, passing about a mile south of Forest City, and by Lake Edward, Crystal lake, and Buffalo Grove, to Lake George, terminating ten miles west of the principal north to south moraine, of which it appears to be a medial branch, produced by convergent ice-currents. Forest City and Lake Edward are respectively five and ten miles west of Pilot Mound, and from them another tract which has frequent moraine accumulations of similar medial origin, varying in width from three to six miles or more, reaches northwestward forty miles through western Winnebago county and northeastern Kossuth county, to East Chain and Fairmont, in Minnesota.

South from Pilot Mound in Hancock county, this terminal line of drift hills has no branch like the foregoing for the next seventy miles, to Mineral Ridge, which may have had a similar origin, but is believed to be more probably an inner belt of the terminal moraine, though the cause of its outer series, supposed to continue southward, has not been explored. Conspicuous portions of this formation are found in eastern Wright county, and in the southwest part of Franklin county; and its entire extent has a promi-

nently undulating, rolling, or hilly contour, in notable contrast **with the smooth,** slightly undulating and often nearly level areas **at each side.** The material of these tracts is chiefly till, with the **occasional exception** of plains of stratified gravel and sand, which **extend a few miles** east or southeast from the moraine. These **deposits of modified** drift are believed to have been brought by rivers **that flowed** down from the surface of the ice-sheet at the west. **Irregularly bedded** gravel and sand occur frequently in the hillocks **of the moraine,** sometimes forming their entire mass, but quite as **often in pockets** or beds of small extent and varying from less **than one foot** to ten feet or more in thickness, included in the till **which almost** universally makes up the greater part of this formation. Aside from such enclosed layers of modified drift, this till **rarely shows** any marks of stratification, and contains more boulders than upon its nearly level tracts.

In Worth county the eastern belt of this moraine enters Iowa in sections 8 and 9, Northwood, and extends four miles southwest, with a width of about 1½ miles, to section 24, Hartland; and then three miles south to the northeast corner of Brookfield. It consists of uneven swells and hills, 30 to 40 feet above the intervening hollows, and 50 feet above Northwood, which is situated 1½ miles southeast, on a plain of valley drift about 20 feet above the Shell Rock river. Next this belt appears to be broken and removed by an offset six miles to the west; and thence its course is south through the east part of Bristol, and through sections 2, 11, 14, 23, 27 and 33, Fertile, its southeast border, being about ⅓ mile northwest of Rhode's Mill, in section 34. In these townships the formation is in knolls, hillocks and short ridges, trending to the south or southwest, and 30 to 60 feet high. At the southwest corner of this county these morainic hills become more abundant and abrupt, and form a very rough wooded belt two or three miles wide, for a distance of six miles west from Rhode's Mills to Pilot Mound. This tract includes parts of four counties, and is bounded on the north by Lime creek.

In Cerro Gordo county the eastern morainic series is represented by a rolling, partly wooded tract, south of Lime creek and 75 feet above it, extending about two miles southeast from Rhodes' Mill, and then turning south. Its next eight miles to Clear lake are a moderately rolling belt from one to two miles wide, and 50 feet higher than the smooth expanse, which reaches thence eastward as far as the eye can see. At the south side of the east part of Clear lake, this moraine occupies a width of about one mile, and is crossed by the road to Belmond; it here consists of many mounds and hillocks, not rising above the general level of the smooth land at each side. Its farther course has not been traced; but the east side of the southwest township of this county, 9 to 15 miles south of Clear lake, reported to have a rolling and knolly surface, probably belongs to this morainic series, and suggests that it will be found to extend approximately south through the east part of range 22 in southwestern Cerro Gordo and northwestern Franklin counties, joining the western belt of this moraine at the southeast corner of Morgan, 10 miles north of Alden.

About a third part of Winnebago county is covered by these hilly drift deposits. Their principal belt, which is the continuation of the range seen at Albert Lea and east of Bear lake in Freeborn county, enters Iowa at the northeast corner of Winnebago county and extends south with a width of from two to four miles, through the townships of range 23, between Lime creek and the east line of the county, to Pilot Mound. The southeast border of this belt is quite definite at a point two miles north and again at one mile west of Lake Mills. Here and southward it consists of massive hills of till 40 to 75 feet high. A branch of this moraine, consisting of rough hills, strown with many boulders, and occupying a width of about two miles, crosses Lime creek a few miles south of the State line, and extends northwest into Kiester, the southeast township of Faribault county. Northeast from this tract is a plain of modified drift, reaching five miles to Bear lake.

The medial moraine which extends northwest from Forest City and Lake Edward attains its greatest height in the north part of T. 98, R. 25, where it is 100 feet above the general level. In northeastern Kossuth county this tract expands to a width of ten miles and reaches from Ramsey, at the east side of Union Slough, north and northwest to the State line, lying on both sides of the head stream of the Blue Earth river. Its northeast border reaches 1½ miles into the south edge of Elmore and Pilot Grove in southwestern Faribault county, forming hillocks and short east-to-west ridges of till, 30 to 50 feet high. Thence these accumulations of till occur scatteringly in southeastern Martin county to East Chain and less prominently to Fairmont. Their contour in these townships is seldom rough, but rises in swells 25 to 50 feet above intervening depressions, with trends more frequently from northwest to southeast than in other directions.

In Hancock county the western and principal belt of the terminal moraine extends from Pilot Mound six miles southwest and then nearly due south through range 24. Pilot Mound in the north part of section three, Ellington, rises about 250 feet above Lime creek, which is two miles farther south. A multitude of rough drift hills, mounds and short ridges, 50 to 100 feet lower than this, reaches six miles eastward and two or three miles to the west and northwest. All these accumulations are till, trending more frequently from east to west than otherwise, of all heights from 25 to 100 feet above the intervening depressions, which are often bowl-shaped or irregular hollows, containing sloughs. The top of Pilot Mound is some 200 feet above the average of the country to the north and south, and from 100 to 150 feet above the sloughs in its vicinity. The hills of Kiester, in Minnesota, 22 miles distant, are visible but not prominent, bearing N. 10° W.* The highest hills seen in Winnebago county are those in the north part of T. 98, R. 25, bearing N. 65° W.* and twelve miles distant. South from Pilot Mound the morainic contour reaches 1½ miles, and is succeeded by a plain of stratified sand and gravel, one-third mile wide, on the north side of Lime creek and 15 to 25 feet above it. These tracts are mainly wooded, but south of this creek the surface soon rises 40 or 50 feet to a broad prairie of moderately undulating till. From Forest City and Silver creek the terminal moraine passes south in a rolling and knolly tract which is from two to three miles wide, through the center of Madison; six miles wide in the north part of Garfield, reaching from the east fork of the Iowa river to Eagle lake; and about three miles wide through the west half of German and of T. 94, R. 24, bordering and crossing the west fork of the Iowa river, and including the Twin lakes.

The hillocks and swells of this tract consist principally of till. They are from 30 to 60 feet high, and average about 40 feet above the comparatively level areas on the east and west. Their prevailing trend, like that of the frequent sloughs of this region, is approximately from north to south. A plain of modified drift is found east of this moraine, reaching five miles from Concord and Garner northeastward. At Garner this is stratified clayey sand and fine gravel, underlain by till, which forms the gently undulating surface at Concord and thence south through Ell and Avery. In this drift sheet the east fork of the Iowa river has cut a channel or valley, which increases in size till at the south line of the county it is one-third mile wide and 75 feet below the general level to which the ascent is by steep bluffs.

A conspicuously rolling, hilly and knolly tract branches from the terminal moraine in the north edge of Hancock county, and extends ten miles westward to Lake George, beyond which the contour on all sides is smooth and only slightly undulating. Many of the hillocks and ridges of this tract trend nearly from east to west. Their material is till, often containing an abundance of boulders. Their height along the north side of Silver creek, in sections 9, 10 and 11, Madison, is 20 to 50 feet, and nearly the same about the lakelets in sections four and five of this township. Lake Edward, Crystal Lake, Lake George, and the series of sloughs and lakelets which reaches three miles southeast from the last, are bordered by very rough, morainic bluffs, which rise steeply 50 to 75 feet at the north side of these lakes. Their top is the edge of a plateau of till, which extends four to eight miles north with a nearly level but slightly undulating surface. Prominent hill ranges of equal height occupy a width of two miles south of Lake Crystal, and of one mile southwest from Buffalo Grove and Lake George. Toward this tract, if it is a medial moraine, currents of the ice sheet and descending slopes of its surface converged from the northwest and southwest. Rivers produced by glacial melting would accordingly flow upon the surface of the ice to this lowest portion of its border; and we find modified drift which was apparently brought by such streams, forming plains that extend several miles southeast from Lake Edward and cover a width of four miles half way between Clear lake and Britt. The only kames observed are at the southeast sides of Crystal lake and Lake Edward, and consist of a few mounds and ridges ten to fifteen feet high, composed of irregularly bedded gravel and sand.

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*Referred to the true meridian.

In Wright and Franklin counties the terminal moraine extends south four miles to Gertrude or Twin Sisters lakes, four miles west of Belmond; thence south, southeast eighteen miles, by the east sides of Cornelia (or Little Wall) and Elm lakes, into Vernon, the southeast township of Wright county; and next east, and southeast nine miles, and then south six miles, crossing the Iowa river at the east side of Wright county, and lying on the north and east boundaries of Oakland, the southwest township of Franklin county. Its width along this distance is from one and one-half to three miles; the material is till, often enclosing and strown with many boulders of granites, schists and limestone; in height its knolls, ridges and hills vary from ten to one hundred feet above the intervening hollows; and their trends, wherever any system is noticeable, are parallel with the course of the moraine. The elevation of this hilly belt above the smooth expanses of till on each side is mostly from forty to seventy-five feet, but due east from Clarion, it does not rise above the general level. This moraine is crossed by the road from Belmond to Clarion, and is there one and one-half miles wide, and consists of many small hills and ridges ten to forty feet above its enclosed hollows of irregular form, which contain frequent lakelets and small sloughs. Its height above the Iowa river gradually rises from fifty feet at its east side to one hundred and twenty-five or one hundred and fifty feet at the west: and it is succeeded by gently undulating till, which maintains about the same height as the upper portion of the moraine and extends indefinitely westward. One to two miles farther north, in the vicinity of Gertrude lake, these morainic hills rise fifty feet higher: and thence a medial branch of this formation reaches three miles westward in the north part of sections 1, 2 and 3, Lake (T. 92, R. 25), culminating in the "Big Mound," which appears to be the highest land in Wright county. The most broken portion of the moraine in this county is ten miles southeast of Clarion, in sections 32 and 33, Blaine, and 4, Vernon, consisting of many mounds and short ridges, twenty-five to seventy-five feet above the intervening hollows, fifty feet above the smooth land westward, and about one hundred and twenty-five feet above the Iowa river. Southeastward this moraine reaches in low knolls to the east half of section 26, Vernon; but its most conspicuous deposits are found on the opposite side of the Iowa river, in southwestern Franklin county, extending east and then south at the north and east sides of Oakland, averaging two miles in width, about half of which is in Morgan and Lee townships, next on the north and east. This belt is very rough with many hillocks and short ridges, generally trending in the same direction with the series, composed of till with abundant boulders, and divided by depressions which often contain sloughs or lakelets. Its height is fifty to seventy-five feet above the smooth areas of till on each side, and about one hundred feet above the Iowa river. The south part of this formation in Franklin county, lying a few miles north of Alden, is commonly called the "Blue Mounds."

Between Alden and Story City the course of the moraine coincides approximately with the line which divides Hardin and Hamilton counties, but scarcely enters the latter, excepting for a distance of eight miles at its southeast corner. In northern Hardin county the line of this formation is again crossed by the Iowa river, southwest of which it reappears in a knolly belt of gravelly till, fifty feet above the general level both to the east and west.

This lies between one-half mile and two miles west of Alden, and thence extends twelve miles south, southwest and south along the west border of Hardin county, reaching one-fourth or one-half mile west of the county line and one to two miles from it eastward. Here and in southeastern Hamilton county it is moderately undulating till, often containing many boulders. Its crests are twenty to thirty feet above the depressions, and twenty-five to fifty feet above the adjoining country. Six to eight miles north of the south line of these counties, the width of this rolling tract is increased to three miles, lying mostly in Hardin county. Thence its course is deflected southwestward and its width narrows to one mile in the south part of Scott, the southeast township of Hamilton county. Its last mounds and knolls seen east of Story City are in sections 28 and 33, Scott, rising forty to sixty feet above the flat area of till, which reaches thence one and one-half miles west and southwest and indefinitely toward the south and southeast, being about thirty-five feet above the Skunk river and twenty to twenty-five feet above its bottomland. Beyond the valley eroded by this river, the same plain of till extends two miles to the southwest and indefinitely to the northwest from Story City. At its southwestern limit a prominently rolling and hilly tract of till rises fifty to seventy-five feet higher and extends thence twenty-five miles west through the northern tier of townships in Boone county.

The Des Moines river intersects this range eight to ten miles north of Boone and Ogden. East of the river it is widely known as Mineral Ridge; and a kame-like hill 1½ miles west of the Des-Moines, and two miles south of the main series of this moraine, but doubtless accumulated at nearly the same time, is called Pilot Mound. The width of this belt averages about three miles. It extends westward through the center and northwest quarter of Harrison, the northeast township of Boone county, where its height is 125 to 150 feet above Squaw creek; but this elevation is due, at least in some portions, to underlying bed-rock, which was encountered at a depth of 35 feet, by wells upon this range in Sec. 16, Harrison. Its material here and westward is till, in which boulders often abound, being of all sizes to 5 and rarely 10 feet in diameter. This belt occupies the north part of Dodge, the township to the west, in which its height contains nearly the same, being about 50 feet above the smooth areas of till that stretch as far as the view reaches to the north and south, and about 250 feet above the Des Moines river, which has here cut a valley 200 feet deep. The largest hills and ridges of this district are in Sec. 6, Harrison, and Sec. 1, Dodge, where they trend nearly from east to west, and rise 75 or 100 feet above adjoining depressions; but because of their comparatively low position they do not overtop other portions which have a less broken surface. The contour of the moraine at the village of Ridgeport or Mineral Ridge, three miles east of the Des Moines river, and for the next six miles east, as also along the north edge of the county for six miles west of the Des Moines river, has been well described by Dr. C. A. White, who writes: "It consists, to a considerable extent, of a collection of slightly raised ridges and knolls, sometimes interspersed with small shallow ponds; the whole having an elevation probably nowhere exceeding fifty feet above the general surface, but being in an open prairie, it attracts attention at considerable distance.*"

Pilot Mound gives its name to the township in which it is situated. This is nearly a round hill about 75 feet above the smooth expanse of till which reaches north two miles to the moraine, east one mile to the bluffs of the Des Moines valley, and southward beyond the horizon. Its base covers a diameter of ⅛ mile, and it rises by steep slopes to a rounded top which has its highest point in the southwest corner of Sec. 21, about three rods east of its west line. This mound is wholly composed of gravel and sand, obliquely stratified, with no till or boulders. Clear sand, in beds 3 or 4 feet thick, occurs at the top of the mound; but it is mainly coarse gravel with pebbles up to six inches in diameter. About half of the pebbles under two inches are limestone, but those of larger sizes are mostly granites and schists. Potsdam quartzite is rare; it may be that one pebble in five hundred is from this formation. West and southwest from Pilot Mound, a moderately rolling surface 50 to 75 feet lower, composed principally of till, extends two or three miles, terminating in Sec. 30, which has mounds 20 to 30 feet high.

A belt of knolly till, similar to Mineral Ridge, extends west from section nine Pilot Mound, into the northeast corner of Grant, the northwest township of Boone county, beyond which its farther course has not been explored; but it is supposed to turn north-northwest, lying within five miles west of the Des Moines river, and to be continuous to a typically morainic tract which was found twenty miles farther north, between 2 and 3½ miles west of Fort Dodge. This tract has many rough hillocks of till, fifteen to thirty feet high, with abundant metamorphic and some limestone

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boulders, but few or none of potsdam quartzite. It may be that similar accumulations are traceable onward in the same course 30 miles to the branch which extends from the terminal moraine at the west side of Palo Alto county east and southeast to the edge of Pocahontas county at the south line of T. 94, R. 32. In that case it would appear that the series of drift-hills explored in northern Boone county, and their tract west of Fort Dodge, are portions of a terminal moraine reaching from northwestern Story county to western Palo Alto county. They must then be contemporaneous with the inner belt of this looped moraine, which extends through eastern Waseca county and by Albert Lea on the east side of Spirit lake, Heron lake and Lake Shetek to Gary on the west.

The outer belt of the terminal moraine at the west side of its loop is found 35 miles southwest from Mineral Ridge, in northern Guthrie county, where its course is from southeast to northwest and it has been traced continuously thence to the north line of Iowa and across southwestern Minnesota into Dakota. From the vicinity of Pilot Mound the next thirty miles to the south and southwest are smooth and only gently undulating till, with few boulders. This tract intervening between Mineral Ridge and the terminal moraine in Guthrie county shows that these cannot be portions of one continuous belt; and if they were formed at the same time, Mineral Ridge must be a medial moraine like those which extend from Kiester northwest across Faribault county, and from Forest City to Fairmont and Lake George.

The exploration of these belts of hilly and knolly drift, reaching from the south line of Minnesota to the center of Iowa, leaves no doubt to the writer that they are opposite portions of a continuous terminal moraine which has its course in a curve like the letter U. Professor Chamberlin has shown that this moraine crosses Wisconsin in a series of loops of this kind; and the large driftless area in southwestern Wisconsin and portions of the adjoining states, surrounded on all sides by glacial deposits, proves that at the time when the ice-sheet reached farthest, its southern portion was similarly divided into vast lobes, which, through a part of this epoch, became confluent at the south side of the driftless area. The lines of moraine here described in Minnesota and Iowa are about midway between this region, which has escaped glacial action on the east, and the limits of glacial drift on the west which extends southward and south-southeastward from about 40 miles west of Bismarck through Dakota and across Nebraska into northeastern

Kansas. These lines of hilly drift are thus more parallel with the boundaries of glacial action at its time of greatest extent, and are supposed to mark the similar limit attained by the ice-sheet of the last glacial epoch. A very significant feature is the frequent occurence of lakes upon the area enclosed by this looped moraine; while in the regions beyond it to the southeast and southwest, though they also are in large part till. lakes and rivers are rare or entirely absent. The connection between the moraine that reaches from the south line of Minnesota in Freeborn county to the northwest part of Story county and Mineral Ridge, and that which is next to be described, is believed to extend southwestward through Story and Polk counties, probably crossing the Des Moines river within a few miles southeast of Des Moines; then westward along the south side of Raccoon river, through the north edge of Madison county; and northwestward along the east side of Middle Raccoon river, through southwestern Dallas county and northeastern Guthrie county.

This western line of the terminal moraine was encountered in the south part of T. 81, R. 31, in northern Guthrie county, after traveling thirty-five miles southwest from Mineral Ridge and Pilot Mound. Its course thence is to the northwest and north through Carroll, Sac, Buena Vista, Clay and Palo Alto, Emmett, Dickinson and Osceola counties, into Minnesota, reaching in Iowa 120 miles to the north and 60 miles to the west. The width of this belt along the greater part of this distance is from two to four miles; but in Clay, Palo Alto and Dickinson counties it is from eight to twelve miles. Its contour is nearly as in other portions of this formation, presenting many hillocks and short ridges which vary in height from 20 to 50 feet above the intervening hollows, and usually rise 30 to 50 feet and rarely 75 or 100 feet above the adjoining country. Eastward a smooth and nearly level expanse of till with few boulders stretches 50 to 75 miles to the eastern line of this moraine. Westward the land next to this belt from Storm lake to the Minnesota line, is nearly the same as on the east; but south of Storm lake the till on the west is buried beneath the loess, which in somes portions has a smooth and gently undulating surface, but generally it has been sculptured by rains, rills, creeks and rivers, to a prominently rolling contour, rising to crests, ridges and plateaus, 100 to 150 feet or more above the streams. Near the moraine this erosion has cut through the loess, and from 50 to 75 feet into the underlying till. The surface of the loess throughout this distance of 75 miles, averages as high as the tops of the morainic hills which lie next to it on the east, and at their lower portions, surpasses them by 25 or 50 feet, while its elevation above the expanse of till eastward is from 50 to 75 feet. The material of the moraine is chiefly till, with boulders everywhere frequent. and occasionally very abundant, probably averaging ten or twenty times more numerous than on the smooth areas of till. These are granites, schists and limestone, as in the eastern line of this formation, with the addition of a considerable proportion from the red Potsdam quartzite which has extensive exposures in southwestern Minnesota from New Ulm to Pipestone City and Luverne. In this moraine on the east from Albert Lea south to Mineral Ridge, these quartzyte fragments are very rare; but along its entire coast on the west, from Guthrie county into southwestern Minnesota, they are common, and make up from one-twentieth to one-third part of all its boulders. The only exposures of bed-rock seen in the regions traversed by this moraine, are in Guthrie county, where the Nishnabotany sandstone of Cretaceous age outcrops along the Middle Raccoon river, at Rock Bluff mills, situated in the N. E. ¼ of Sec. 27, Highland (T. 81, R. 32). and at other points. The hills of the abjoining moraine, covered at the surface by knolly till with many boulders, are found by wells to consist in some cases for their lower portion of this sandstone, showing that the contour here partly conforms with the unequally eroded surface of rock beneath the drift.

In northern Guthrie county the morainic belt covers a width of about two miles next northeast from the Middle Raccoon river, reaching to Swan lake in the southeast quarter T. 81, R. 31. Its elevations mostly trending north-westward, are from 30 to 75 feet above the hollows. Boulders abound and include many of Potsdam quartzyte, which occurs in fragments of all sizes up to five feet in diameter. They are most plentiful where the surface is most broken. as in section 18, of Highland, and sections 13 and 12, of Grange, the northwest township of this county. The hills, knolls, and ridges of these sections appear to be composed wholly of till. In a well near top of one of them, this was yellowish to a depth of 25 feet, then dark bluish and harder for 22 feet below, to water which arose 16 feet.

In Carroll county this belt, from 1½ to three or four miles wide, continues northwestward by Coon Rapids, Carrollton, Carroll and Maple Junction to Breda. From the southeast corner of the county to Gustine Grove, two miles beyond Carrollton, it consists of swelling hills of till, not so rough as to be typically morainic, which occupy a width of 1½ to three miles along the northeast side of Middle Raccoon river, rising from 100 to 150 feet above it, and averaging 75 feet or more above the smooth sheet of till on the east. Between one and two miles northwest from Carrollton some of these hills, 100 feet above the river, consist of loess at the surface, free from pebbles to a depth of ten or 12 twelve feet. This has the same yellowish color as the upper part of the till. Other hills near have many rock fragments, both large and small, being common till, but morainic in the abundance of boulders. From Gustine Grove to Carroll the moraine holds its straight course northwestward, lying on the southwest side of the river, which here flows east and then south. Its height is from 100 to 125 feet above the river. A part of its mounds and hillocks through this distance are covered by loess, but mostly their surface is till with numerous boulders and pebbles. A lakelet two miles south-east of Carroll, and frequent sloughs, lie in the depressions of this formation. Beyond Carroll the Middle Raccoon river is again its southwest boundary, from which it reaches to Mount Carmel. It here consists of moderately rolling till, with crests 30 to 50 feet above its hollows; and this character continues to the north line of the county where its course is through the northeast part of Wheatland, its northwest township, with a width that reaches about a half mile east and two miles west of Breda.

Across Sac county and to the center of Buena Vista county, a distance of thirty-six miles, the course of the moraine is a few degrees west of north, and its width is from two to four miles. In Sac county this extends from the southeast quarter of T. 86, R. 36, to the northwest quarter of T. 89, R. 36. Wall lake lies within the limits of this belt, and its west border is close east of the railroad town of Wall lake. Farther to the north, Indian creek and lake are at the west side of this belt, which through Sac county consists of moderately rolling and often knolly till, containing frequent boulders and pebbles. Its crests are 20 to 30 feet above the adjoing hollows, sloughs and lakes. Next to the west the loess rises forty to fifty feet higher than the moraine, forming nearly level-topped plateaus and ridges, as in the southwest quarter of T. 86, R. 36, and at the west side of the Boyer River west of Wall lake, or smooth swells which rise in long slopes thirty to fifty feet above the intervening depressions, sometimes having considerable gravel and boulders up to one foot in diameter at their top, apparently due to exposure of the underlying till, as in the six miles north from the town of Wall lake, and in Ts. 88 and 89, of R. 37. The lowest point of the watershed between the Mississippi and Missouri rivers in the northern two-thirds of Iowa, appears to be the slough which reaches from Wall lake, four miles southwest to Boyer river.

In Buena Vista county this belt of rolling and knolly till, from two to three or four miles wide, continues north-north-westerly by the east end of Storm lake and to the south part of Scott, 7 miles north of this lake; thence it bends to the north and northeast, and passes by Grass Lake and Green Mound, to Pickerel Lake at the northeast corner of the county. From the northeast part of this belt a branch extends six miles south through the range of sections from 2 to 35 in Lincoln (T. 92, R. 36.) Both in this branch and in its main series, the hillocks, mounds and short ridges of this formation usually rise only from 10 to 30 feet above its depressions. Rock fragments of all sizes up to two or three feet in diameter abound, but larger boulders are infrequent. The west border of this belt is a half mile east from the town of Storm Lake. Its knolly surface is well seen at two miles east, two to three miles north, and five miles north of this town. Green Mound, situated in Sec. 19, Poland, five miles southwest from Pickerel Lake, is one of its most conspicuous hills in this county, though only about 50 feet high. Scarcely anywhere in Iowa does this moraine attain such height that it deserves to be designated on an ordinary map; but in a study of the glacial drift, its rough surface and its abundant rock fragments very clearly distinguish this formation, in its two nearly parallel north to south belts, from the smooth sheet of till, holding few stones and boulders, which covers the intervening area. In crossing this expanse 80 miles wide, from eastern Buena Vista county east to northwestern Hardin county, drift and contour like those that characterize this moraine, were seen at only one place, 2 to 3½ miles west of Fort Dodge, as already described.

Northward the moraine is 8 to 12 miles wide, occupying the greater part of the east range of townships in Clay county and the west range in Palo Alto county. Its material is till with many boulders. Much of Swan Lake, the northwest township of Pocahontas county, and of Rush Lake and Silver Lake in southwestern Palo Alto county, have the rolling or knolly surface of this formation, with crests 20 to 40 feet high; but its most broken contour and most prominent hills, 50 to 75 or 100 feet in height, are found northwest of Pleasant and Mud lakes in the southeast township of Clay county. About Elk and Elbow lakes and Ruthven, its mounds, ridges and hillocks are 20 to 60 feet above the depressions and lakes. Farther to the north the moraine is divided into two belts, one of which passes by the east side of Lost Island and Palo Alto lakes into Emmett county, while the other lies south and west of Lost Island and Trumbull lakes and extends north into Dickinson county. Between these belts; in their course for 25 miles to Spirit Lake, is a tract of smooth, moderately undulating till from four to six miles wide. The eastern series of drift hills here and in their continuation across southwestern Minnesota, corresponds to the series at the east side of this morainic loop, as at Albert Lea. These are an inner terminal moraine which was evidently accumulated at some time later than the outer moraine, but both appear to have been formed by the ice-sheet of our last glacial epoch. It has been shown on a preceding page that Mineral Ridge is probably a portion of the inner belt of this formation, and that it may be traceable across Webster and Pocahontas counties to a branch which extends southeastward from the outer moraine in Palo Alto county. This branch first takes an easterly course from the vicinity of Silver Lake through the south part of Great Oak township to the Des Moines river, 7 miles southeast of Emmettsburg. Thence it turns southerly, occupying nearly the entire northwest quarter of Ellington (T. 94, R. 32), and continues in a narrow line of knolls from the center of this township to its south line. It consists of till with many small and large boulders, and its surface rises in knolls and short ridges 20 to 30 feet above the general level, and 50 to 75 feet above the Des Moines river. The morainic hills in the western townships of Palo Alto county, most typical in Highland and in the west part of sec. 1, at the northeast corner of Silver Lake, are 125 to 150 feet above this river, and from 40 to 60 feet above Rush, Silver, Elbow, Lost Island and Palo Alto Lakes.

The inner morainic series lies at the west side of the Des Moines river in Emmett county, extending north through Twelve Mile Lake, Esterville, and Emmett, to west range of townships. It is very finely exhibited for three miles to the south and east from Twelve Mile Lake, its highest portions being about forty feet above this lake or one hundred and fifty above the river. Here and onward through this county and in northeastern Dickinson county, it consists of typically rough, knolly till, with the usual abundance of boulders, one-third to two-thirds of which are the red Potsdam quartzyte. The width of this belt in Emmett county is from two to three miles, and its height is from one hundred and twenty-five to one hundred and seventy-five feet above the Des Moines.

Twelve Mile and Cheever lakes lie at its west boundary, beyond which the west edge of Twelve Mile lake and Estherville and the next four or five miles into Dickinson county are slightly undulating till, which mostly lies twenty-five to fifty feet lower than this moraine, but rises northward to a height of twenty-five feet above it at a half mile south of Swan lake. East of the Des Moines river its bluffs in Emmett county are from seventy-five to ninety feet high, and from their top a gently undulating sheet of till, maintaining nearly the same elevation, stretches eastward into Kossuth county and beyond the East Fork of the Des Moines. In the northern, two-thirds of Superior, the northeast township of Dickinson county, this series of rough drift hills turns westward and extends with a width of about three miles by Swan lake to Spirit lake. Their height is twenty-five to fifty feet above the numerous enclosed sloughs and lakelets, being in the east half of the township from one hundred and fifty to one hundred and seventy-five feet above the Des Moines river and fifty feet above Swan lake, but rising in its west part fully fifty feet higher to a watershed about seventy-five feet above Spirit lake.

In Dickinson county the outer belt of this moraine covers about half its area, including the west edge of Lloyd and Richland (Ts. 98 and 99, of R. 35), the northeast part of Milford (T. 98, R. 36), and nearly all of Center Grove, Lakeville and Excelsior, and of Spirit lake, Diamond lake and Silver lake (Ts. 99 and 100, of Rs. 36, 37 and 38). Its material throughout this county is the usual till with many boulders, of which from one-sixth to one-third are Potsdam quartzyte. Its surface is diversified by frequent hillocks and knolls, whose crests are from twenty to forty feet above the intervening hollows, sloughs and lakelets. This county has the most notable group of lakes in Iowa, distinguished equally for their beautiful scenery and for their abundance of fish and game. They are Spirit lake, four miles in diameter and the largest in the State, lying just south of the State line at the northeast side of this morainic belt, and the West and East Okoboji lakes, each about six miles long, lying inside its limits, with more than a dozen small lakes near them, varying from one-fourth to one mile in diameter. The maximum depth of Spirit lake is reported to be about 50 feet; of West Okoboji, in its north half, 55 feet, and in its south half, more than 100 feet; and of East Okoboji, 15 feet toward the north and 25 feet toward the south. The Okoboji lakes have the same level, and are from two and one-half to four feet below Spirit lake, according to their varying stages of water.

Their height above the Des Moines river at the State line is estimated to be about 150 feet. Nicollet's barometric observations made Spirit lake 1310 feet above the sea; but this appears to be 75 or perhaps 100 feet less than the truth. East of Spirit and East Okoboji lakes these tracts of hilly and knolly drift rise 75 to 100 feet above them; the highest elevations between the Okoboji lakes are 50 to 75 feet; and the typically rough, morainic hills west of West Okoboji and Spirit lakes are from 75 to 125 feet high. The northwest part of this county has frequent swells, knolls, and short ridges, which rise 10 to 40 feet above the depressions, but none of them much exceeds the average height of the whole region, which gradually rises westward, and attains in northeastern Osceola county, 12 to 25 miles distant, an altitude from 75 to 150 feet above the highest hills near Spirit and West Okoboji lakes.

In Osceola county the south-west boundary of the morainic belt runs from Sec. 25, T. 99, R. 39 west, north-west to Ocheyedan mound, and thence north-westward coincides nearly with the course of Ocheyedan creek. Its width extends from this limit north-east into the edge of Minnesota; but it encloses a tract of nearly level, gently undulating till, 4 miles wide and 5 miles long, reaching from Rush lake east to the county line. The contour and material of the moraine continue the same as in north-western Dickinson county. The highest portion of this formation in Iowa, and probably at the same time the most elevated ground within the limits of the State, is either the top of Ocheyedan mound, or the smaller swells and hillocks next to the State line, 9 miles further north-west, which are about 1,675 feet above sea, the railroad station of Bigelow, near by in Minnesota, being 1,631. Ocheyedan mound situated in the S. W. ¼ of Sec. 12, T. 99, R. 40, is a steep ridge of unequal height and irregular form, about 500 feet long, tending S. 50° E., composed of very pebbly gravel, or perhaps till, with a few boulders, 1 to 3½ feet in diameter, scattered upon its [sides and top. It rises 50 or 60 feet above the average of its region, and about 125 feet above Ocheyedan creek. Though so small it is the most conspicuous elevation of Osceola county. It is estimated to be 1,650 feet above sea, but upon exact determination it may be found to exceed this and be the highest land in Iowa, a distinction which has been erroneously assigned, with an exaggerated height, to the hills near Spirit lake. Southern and western Osceola, south-western Dickinson, much of O'Brien, western Clay, and north-western Buena Vista counties, lying next beyond this moraine, are overspread with a smooth, slightly undulating sheet of till, at least from 100 to 200 feet in depth, as shown by the deep valley or channel of the Little Sioux river, and by wells which nowhere penetrate to the underlying rock. Farther south-west this deposit is concealed beneath the loess, which extends from the Missouri river 60 miles east to Storm lake and 75 miles north to Luverne.

THE COTEAU DES PRAIRIE.

A large area in southwestern Minnesota and eastern Dakota has an elevation from 500 to 1000 feet above the Minnesota river, and from 1300 to 2000 feet above the sea. Upon this highland district are the sources of Lac qui Parle, Yellow Medicine, Redwood and Cottonwood rivers, tributary to the Minnesota river; of the Des Moines river, and of the Little Sioux and Big Sioux rivers, tributary to the Missouri. The outer belt of the terminal moraine forms the highest portion of this area, and extends in Minnesota from southeastern Nobles county in a nearly north-northwest course, passing west of Worthington, through southwestern Murray county, the northeastern township of Pipestone county, and southwestern Lincoln county, by the west ends of lakes Benton, Shaokatan and Hendricks, into Dakota, where it continues in the same course through Deuel and Grant counties and the Sisseton and Warpeton Indian reservations. It thus reaches past the sources of the Big Sioux river, and farther northward becomes the divide between the head streams of the Minnesota river on the east and the James river on the west. This elevated tract, extending 200 miles, was called by the earliest French explorers the *Coteau des Prairies*, meaning the highlands of the prairies. This name, according to Nicollet, alludes to its conspicuous appearance, "looming as it were a distant shore," when viewed from the valleys of the Minnesota and James rivers, as is very noticeable from the vicinity of lakes Traverse and Big Stone, and from the highest points near the Minnesota river for perhaps 20 miles below Big Stone lake. Farther southeast this title was generally applied to the first prominent ascent above the broad, gently undulating expanse that reaches everywhere 20 or 30 miles from the Minnesota river. Before coming to this in going southwest, there is generally a very gradual slope, rising 100 or perhaps 150 feet in the last ten miles; then comes the steeper acsent which amounts to 200 or 300 feet within a width of two or three miles, coinciding through the greater part of its extent across southwestern Minnesota with the tract of knolly and hilly drift that forms the inner belt of the moraine. The general height beyond, sometimes after a slight descent, continues to rise, but only slowly, amounting to 100 or 150 feet in crossing the smooth gently undulating area between this and the outer morainic range, which divides the waters of the Minnesota, Des Moines and Little Sioux rivers on the east from those of the Big Sioux river, and its tributaries on the west, forming, as already mentioned, the highest part of the Coteau des Prairies.

The inner line of hills of the terminal moraine extends from Spirit lake north and northwest through Jackson, Cottonwood, Murray, Lyon, Lincoln and Yellow Medicine counties, to Gary, where it enters Dakota, 11 miles west, northwest from Canby. From the west side of Spirit lake its course is north through Minneota, Hunter, Heron Lake and Delafield, the central range of townships in Jackson county. The width of this belt is from three to six miles. Its surface is prominently rolling, mostly in massive swells 20 to 40 feet above the depressions, but at many places in small, steep knolls and hillocks of similar height. The elevation of the range above the general level is from 30 to 50 feet. Its material is till, which here contains more gravel and boulders than on its smooth, slightly undulating areas which extend at each side beyong the limits of the county. The Des Moines river, east of this moraine, has excavated a valley 100 feet deep in this sheet of till, without exposing the bed rock; and G. C. Chamberlin's well at Jackson in this valley, went 130 feet in till with only thin beds of sand, not reaching its base at this depth, which is 100 feet below the river and 200 feet below the top of its bluffs. The railroad well at Heron Lake found the drift 186 feet deep, underlain by the red Pottsdam sandstone or quartzyte. In Minneota this morainic belt is about three miles wide, reaching from Little Spirit Lake and Clear lakes west to the Little Sioux river. It here has many knolls and short ridges which continue into Hunter, and are crossed 7 to 10 miles west of Jackson by the road to Worthington. Northwest from Jackson it is represented by the rolling tract about six miles wide, between the Des Moines and Heron Lake, west and southwest of which is a very flat expanse of till, 10 to 20 feet above the lake, stretching with slowly increasing height as far as the view extends westward.

In Cottonwood county this moraine continues north to the great bend of the Des Moines river, six miles northwest of Windom.

Thence its course is northwest through the north part of Springfield, northeastern Southbrook, southwestern Amo and Rose Hill. Its most conspicous portion and most roughly broken contour are in the Blue Mounds, which lie three miles west of Windom. This group or range of hills, composed of till with frequent boulders, extends three miles in a northwest course, parallel with the Des Moines river on the northeast, and Spring Lakes on the southwest. Their height is 100 to 150 feet above the river and 50 to 75 feet above the general level at their west side. Beyond the Blue Mounds this inner morainic belt is crossed by the Des Moines, which here flows eight miles northeast, at right angles with the rest of its course. Thence to Lake Shetek this belt is a prominent rolling tract several miles wide, rising about 100 feet above the river, and interspersed with lakes. The Des Moines river lies within a few miles at the southwest, being nearly parallel with the moraine; as it is also, but on the opposite side below this bend. East of Windom, a part of this formation, consisting of irregular hillocks of till with enclosed hollows and lakes, occupies a width of two or three miles, and forms the ascent of 75 or 100 feet above the Des Moines river, to a higher, smooth and nearly flat expanse of till, which thence extends 75 miles eastward, descending with an imperceptible slope to the Blue Earth river, and beyond this, rising in the same manner to the eastern series of this curved moraine at the sources of the Le Seuer and Cannon rivers, where Nicollet called it "the N. E. prong of the Coteau des Prairies." The hilly tract mentioned east of Windom appears to be part of a medial moraine branching from the terminal series on the west and extending north through the two western ranges of sections in Lakeside and Carson. Its most broken portion is found in Secs. 17, 8 and 5, Carson, which have many small hills and ridges 40 to 75 feet high, mostly trending from north to south, composed of till with abundant boulders. Ten miles farther north an isolated morainic area is found in Stately, the southwest township of Brown county, reaching from the elbow of Mound creek six miles west into the edge of Germantown in Cottonwood county, with a width of three to four miles, bounded on the north by the Cottonwood river. It is crossed by the lower paft of Mound creek, so named because of its mounds, ridges and hills of till, which are 25 to 75 feet high, abrupt and strown with boulders and pebbles. Between these areas of small drift hills in Carson and Stately is a massive ridge of red Pottsdam quartzyte, which extends 25 miles from west to east through Storden, Amboy, Delton and Selma, in northern

Cottonwood county, terminating in the west edge of Adrian, the northwest township of Watonwan county. This highland is mostly covered by a smooth surface of till, but has frequent exposures of the rock. Its altitude increases from 100 feet at its east end to 250 feet westward above the broad, slightly undulating sheet of till which covers the region at its north side, excepting the morainic tract in Stately, and reaches 25 miles north to the Minnesota river. The height reached at the top of this quartzyte ridge, from 1300 to 1400 feet above the sea, is a peramnent rise of the land which southwestward holds nearly this average elevation to the Des Moines river.

In northeastern Murray county the inner morainic belt, two to four miles wide. extends from Lake Eliza northwest by Duck and Buffalo lakes and the northeast side of Lake Shetek, occupying the northeast part of Des Moines river township, southwestern Dovray, northeastern Murray, the southwest half of Shetek, and the northeast part of Lake Sarah. It is distinguished from the slightly undulating areas of till at each side by its more frequent boulders and its more rolling and occasionally hilly contour; but it scarcely anywhere exhibits the rough surface which characterized the greater part of this series of drift accumulations. The crests of its swells are thirty to forty feet above the intervening depressions, sloughs, and lakes; nearly the same above the general level on each side; and from 75 to 100 feet above the Des Moines river and 40 to 50 above Lake Shetek. The only part of the series in this county which rises in mounds that are conspicuously seen at a distance of several miles is in the northeast corner of Murray township, upon an area from one-half to one mile wide, extending two miles northwesterly from Buffalo lake; but its hills here are only 30 to 50 feet above the average height of the range. Along the northeast side of the northwest area of Lake Shetek, commonly called the "Inlet," are frequent small patches where boulders nearly cover the ground, mostly forming knolls from 3 to 5 or 10 feet high, and occurring from the lake shore to 25 feet above it.

The inner terminal moraine east of Lake Shetek and in Lyon, Lincoln and Yellow Medicine counties forms the northeast border of the Coteau des Prairies, which has a width of about twenty miles, its southwest border being the outer and more prominent terminal range of drift hills which extends by the west ends of Lakes Benton, Shaokatan and Hendricks. From the Blue Mounds in southern Cottonwood county to Gary in the edge of Dakota, the course of the inner series of this formation is northwest and nearly straight. In Lyon county its northeast boundary passes through the center of Custer, Lyon and Island lake townships, and follows approximately the line between this and Lincoln county, for the next six miles at the west side of Nordland. It crosses northeastern Lincoln county from the southeast corner of Altavista to section 3, Marble, six miles south of Canby; and in Yellow Medicine county its course is from section 33, Norman, to section 7, Florida. The most rough and hilly part of this morainic belt is from ½ to 1½ miles wide at its northeast side, where it usually has many irregular knolls, short ridges, and hills, which rise from 25 to 50 feet, and occasionally 75 to 100 feet above the intervening depressions. Their conspicuous appearance, as seen from the northeast, is due to the ascent westward of the country upon which they lie. The Coteau des Prairies, in these inner and outer series of drift hills and upon its intervening tract of smooth or moderately rolling land, has no exposures of the bed rock, but the elevation of this highland is doubtless caused by the altitude of the underlying rock surface, upon which the drift has been deposited as a sheet which is commonly from 100 to 200 feet thick throughout the western two-thirds of Minnesota. From the specially hilly northeast margin of this morainic belt its width reaches five to fifteen miles southwestward with a rolling and in some places knolly or hilly surface, including the greater part of the distance to the parallel outer range of drift hills, but leaving next to that a smooth slighly undulating tract, three to five miles wide. In Marshfield and Lake Stay (Ts. 110 and 111, of R. 44) this smooth contour extends eight miles north from the Cottonwood lake (dry during the last two or three years,) and the east end of Lake Benton, its limit being here twelve miles from the outer moraine. All these areas are till, with many boulders upon the portions which are most broken by knolls, hills and hollows.

The Antelope Hills and Valley. A third well marked series of low broken hills and ridges of till, with abundant large and small rock-fragments, is found in Yellow Medicine and Lac qui Parle counties, lying 8 to 12 miles northeast from the inner morainic belt of the Coteau, and extending north, northwest 40 miles within the limits of Minnesota. The width of this morainic series is usually from one-fourth to one-half mile, being less than that of the specially knolly belts upon the Coteau des Prairies. It appears like them to be a terminal moraine ; and its location shows that it was accumulated after a second retreat of the ice-border. The slight readvance by which these hillocks was heaped at its termination seems not to have occurred generally to other portions of the ice-sheet; at least a corresponding third distinct moraine has not been noticed by me elsewhere. This formation begins in sections 32, 29 and 19, of Burton (T. 114, R. 43), in Yellow Medicine county; continues through sections 13, 11 and 3, of Vergeland (T. 114, R. 44), with similar outlaying hillocks and ridges in sections 9, 15, 16, 21, 22 and 23, of this township; and for the next six miles northward, lies in the southwest edge of Oshkosh and the northeast edge of Hammer. In Lac qui Parle county this moraine forms the two conspicuous clusters of the Antelope hills, in sections 27 and 16, Freeland (T. 116, R. 45), elevated 40 to 100 feet above the smoothly undulating till of their region. Its continuation runs from section 32, T. 117, R. 45, in a nearly straight course to section 33, T. 119, R. 46. One of its hills, about 60 feet high, at the north side of the west branch of Lac qui Parle river, in section 18, T. 117, R. 45, has been named Mt. Wickham. Thence for five miles northerly this knolly belt, 10 to 40 feet above the general level on each side, is known as the Stony Ridge. In T. 119, R. 46, the range seems to be offset three miles to the northeast, from section 33 to section 14, and thence it extends west, northwest to the State line. In the east edge of Dakota, these accumulations rise prominently in the fractional T. 120, R. 47, and are called Yellow Bank hills, from the river of this name which here flows through them. Mt. Tom, their highest point, in or near the N. E. ¼ of section 32 of this township, has an elevation of about 100 feet. A belt of rolling land, about three miles wide, higher than the more gently undulating areas on each side, continues from these hills northwesterly across Grant county and into the Sisseton and Warpeton reservation, lying within six miles northwest of Big Stone lake, and having its east side at about the same distance west of Brown's Valley.

Between this morainic belt and the foot of the Coteau on the west is the Antelope Valley, so named by the Sioux. This is a broad shallow depression, with a slightly undulating surface of till, being from three to ten miles wide, and reputed to extend 125 miles, from the northwest township of Lyon county in Minnesota to the south bend of the Sheyenne river in Dakota. The moraine of the Antelope hills and the smooth area of till on its east side average 25 to 50 feet higher, but have some lower portions, allowing streams to cross the Antelope Valley transversely; and next to the west the Coteau rises about 700 feet within ten or fifteen miles.

The outer or western moraine belt of the Coteau des Prairies extends into the south edge of Minnesota along its course of 20 miles, next west from Spirit lake, where the greater part of its width lies in Iowa. From the Little Sioux river at the west side of Minnesota in Jackson county, to Indian lake in southeastern Nobles county, the width of this formation in our state is from 1½ to 5 miles, reaching north to Skunk lake, to ½ mile beyond Rush lake, to Plum Island and Round lakes, and to the north end of Indian lake. Its greatest extent north in this distance is at the north side of Round lake; but south of this a tract about two miles wide and three miles long to the east from State Line lake, is smooth and only slightly undulating, though enclosed by rolling or knolly morainic areas.

In its northwestern course across Nobles county this belt has a width of about five miles to the center of the county and Summit lake, including the southwest part of Indian lake, nearly all of Bigelow, the northeast edge of Ransom, southwestern Worthington, the northeast half of Dewald, and the south half of Summit lake, with a spur extending north through sections 14, 11, and 2, of the last named township. Onward in T. 103, R. 42, and in the west half of Willmont, its width diminishes from three or four miles to about one mile. Its contour through Nobles county is prominently rolling in swells that trend approximately from southeast to northwest, and rise 50 to 75 feet above the smooth, slightly undulating area next northeast, which extends thence with an imperceptible descending slope northeastward 20 miles to the inner moraine beyond Heron lake and the upper part of Des Moines river. Westward the surface is in swells which trend mostly from north to south, more massive and smoother than those which form the outer terminal moraine, and of about the same elevation; or in nearly level, equally high plateaus; as at Rushmore, 10 miles west of Worthington, and in the southwest part of Little Rock. The material of Nobles county is nearly everywhere till or boulder-clay; excepting the plain with a subsoil of gravel and sand, which occupies the southern two thirds of Grand Prairie, its southwest township, surrounded by swells of till 40 to 75 feet higher.

In western Murray connty and northeastern Pipestone county the outer moraine rises in a conspicious series of drift-hills, which continues thence 150 miles north-northwest as a belt of very knolly and hilly drift from one to five miles wide, to the head of the Coteau des Prairies, west of Lake Traverse. Throughout this distance its material is till with abundant boulders and pebbles, principally of granite, syenite, gneiss and schists, but also including many of limestone. Its surface is broken by a multitude of mounds, short ridges and hillocks, from 10 to 50 feet above the hollows which occasionally contain sloughs and lakelets. From Murray county to the center of Deuel county in Dakota, west of Gary, this morainic belt form a range 50 to 100 feet above the smooth till at its west side which is either in massive swells, as generally in Pipestone county, or farther north, in slightly undulating and often nearly flat slopes which descend westward to the Big Sioux river. At the east side of this range gently undulating till from 100 to 200 feet covers an area 15 to 20 miles wide, in central Murray county, and a narrower belt through Lyon county, reaching to the borders of the inner moraine. In northern Deuel county and northward through Grant county to the source of the Big Sioux river, the two morainic series lie nearer together, and the three or four miles intervening between their roughest belts have a rolling and in some places knolly surface, which rises 75 or 100 feet per mile westward to the west side of the outer moraine. Through this distance and north to the head of the Coteau des Prairies this ascent reaches an elevation about 1000 feet above the Minnesota river and Big Stone and Traverse lakes. Though no exposures of the bed-rock have been found upon this highland, it is believed to rise here much higher than in the valley sof the Minnesota, Big Sioux and James rivers at each side. The altitude of the Coteau is probably thus caused by the greater height of the rock upon which these drift deposits lie, rather than by their extraordinary thickness beyond that which they commonly have throughout southwestern Minnesota. The depth that is added to the general drift-sheet by the accumulations of the terminal moraine does not appear to average more than 50 to 75 feet; and its highest hills found in the exploration of this formation through Minnesota, Iowa and southeastern Dakota, very seldom exceed a height of 100 or 150 feet above the general level of the country. The only tract of considerable extent where they attain a greater elevation is the Leaf hills in southern Otter Tail county, which, for a distance of 25 miles, are from 100 to 350 feet high. Upon the most prominent portion of the Coteau des Prairies extending from Deuel county northward, the knolls and hillocks of this moraine rise 20 to 50 and rarely 75 feet above the adjoining hollows; and the thickness which it adds to to drift-sheet appears to be from 50 to

100 feet. That the prominence of this highland is not due to these morainic accumulations is shown by the greater elevation that is reached within from two to five miles distance by the smooth sheet of till at its west side, which forms the watershed. and beyond decends to the Big Sioux river.

The outer moraine in Murray county includes the west edge of T. 105, R. 42, being here from one-fourth of a mile to one mile wide, the south two-thirds of Leeds, the northeast two-thirds of Chanarambie, its most conspicuous portion in this county being Buffalo ridge, 100 to 150 feet high, trending from southeast to northwest, in sections 21 and 16 of this township; the west half of Cameron, and the southwest corner of Ellsworth. Its area in Leeds, extending six miles east from the main course of the series, and surrounded on the south, east and north by a lower expanse of smooth, slightly undulating till, may be a medial branch. Eight miles northeast from this, in sections 8 and 5, Mason, is a remarkable plateau of till, with its top nearly level, and covering 1½ square miles, from which there is a descent of about 200 feet in three miles east to Lake Shetek, and about 100 feet in the same distance west to Bear lakes.

In northeastern Pipestone county the morainic belt is about three miles wide, and extends through the northeast part of Rock, the center of Ætna and the northeast edge or Fountain Prairie. In Ætna, the northeast township of this county, it is quite picturesquely, broken in knolls and spurs, which rise gradually to a height of 100 to 150 feet above the land on each side.

In Lincoln county this moraine is about two miles wide, and extends north-northwest by the west ends of lakes Benton and Shaoakatan, passing through the middle of Lake Benton township, the southwest corner of Diamond lake, the center of Drammen and southwestern Shaokatan. Its height from its east edge is 100 to 200 feet, and from its west edge 40 to 75 feet. This morainic belt and the thick sheet of till which is massed against its west side and descends thence westward, are penetrated in the west part of Lake Benton township, by a deep channel or valley, which is called, translating its Sioux name, "The Hole in the Mountain." The railroad between Lake Benton and Verdi goes south-southwest four miles through this gap, bounded on each side by picturesque bluffs which are buttressed by steep spurs and cut by deep tributary ravines. Its depth, wholly in the glacial drift, is from 150 to 200 feet below the knolly surface of the moraine, and its highest point is about 15 feet above Lake Benton, which has its outlet eastward into the Redwood river. This valley, from ⅛ to ¼ mile wide, was evidently excavated by a river that flowed from northeast to southwest across this great ridge, which is the highest land in southwesterm Minnesota, being 1000 feet above the Minnesota river at the northeast, 350 feet above the Big Sioux at the west, and about 1960 feet above the sea. For three-fourths of a mile southwest from Lake Benton, this channel is double, being divided by a remnant of the morainic range, which rises nearly as high as the enclosing bluffs. The east pass is called the "Dutchman's Gap," and through it the carriage road goes south and then southwest to the "Hole in the Mountain."

At three other places, 11, 14 and 18 miles northwest from Lake Benton (see map of this region on plate VI), similar channels have been noted through the massive ridge of this moraine and through the smooth sheet of drift that slopes downward from its west side. The first of these channels begins at the southwest end of Lake Shaokatan, and first extends about two miles southwest, in the same course with this lake, through the knolly belt of the moraine, beyond which its course for the next three miles is northwest along its west side, crossing the State line, from section 31, Shaokaton, to the east part of section 21, T. 111, R. 47. There it is joined from the northwest by the second of these channels, which enters the moraine in the southwest quarter of section 7, Shaokatan. This is the only one of these gaps through which the drainage now takes place, as at the time of their excavation, from the northeast to the southwest side of the morainic range. Bluffs 75 to 100 feet high form the sides of these valleys, enclosing a nearly flat bottom land which varies from 300 to 800 feet in width. Lake Shaokatan outflows northeastward to the Yellow Medicine river; but the highest part of the valley that extends from it southwest and then northwest, is only slightly elevated above it. The southwest course of the second channel is continued 2½ miles below their junction, having about the same depth and width, to the center of section 30, T. 111, R. 47, where it enters the last of these remarkable valleys. This lies wholly in Brookings county, Dakota. It extends six miles southward from the southwest end of Lake Hendricks, and then about a half mile beyond the confluence of the valley from Lake Shaokatan, it turns west-southwest. Its depth for the first two miles south of Lake Hendricks, where its bluffs are capped by the knolls and short ridges of the moraine, is from 150 to 200 feet. Along the remainder of its course to the mouth of the tributary channel, its bluffs ascend steeply about 100 feet, and from their top a moderate slope rises 40 to 50 feet higher. Below this junction the valley slowly diminishes in depth, and after six miles reaches an area of low land in the northwest part of T. 11, R. 48. which stretches thence to the Big Sioux river. A nearly flat bottom land from 1-10 to ¼ mile wide extends from Lake Hendricks the entire length of this valley. Its highest part, 1½ miles from the lake, is about 15 feet above it, the outlet of this lake being northeastward to the Lac qui Parle river.

The channel which has been last described, running south from Lake Hendricks, was called by the Sioux "The Brother of the Hole in the Mountain," because of its close likeness to the pass south, southwest from Lake Benton. The west end of these lakes. for about a mile of each, are bordered by hillocks and high bluffs, and occupy the extremities of these channels at their entrance within the limits of the moraine. Lake Benton is six miles long and from one-half mile to a mile wide, its greatest width being at the northeast. Lake Shaokatan is about three miles long, and from one-eighth two three-fourths mile wide, its maximum width being near the middle. The southwest end of this lake is at the northeast edge of the morainic belt. Lake Hendricks is three and one-half miles long, and its width varies from one-fourth to three-fourths of a mile, being greatest near its northeast end. The maximum depth of each of these lakes is reported to be about 15 feet; and they are bordered on all sides excepting the west by smoothly undulating till, which varies from 10 to 30 feet, or rarely 50 feet, above them. Thus the hollows in which they lie sink about 40 feet below the general level of the drift-sheet at the east side of the morainic range, and about 30 feet below the highest part of these channels which are continuations from them through this moraine and the thick sheet of till at its west side. Nowhere else for at least 50 miles next to the northwest from Murray county is this massive ridge intersected by any similar channel, and its altitude throughout this distance is from 100 to 200 feet above these lakes. Its highest portion, forming a belt about two miles wide, marked by many hillocks and hollows, appears to have been pushed out at the margin of an ice-sheet that lay upon its northeast side. The excavation of these channels took place at the same time with the accumulation of this moraine, or more probably at the close of this part of our last glacial epoch, when the ice was being rapidly melted, but before it had receded to its inner line of moraine; for the thick mass of the ice-sheet, rising high above its terminal deposits, is the only barrier that we can suppose to have existed to turn the course of drainage across this highland, which is now the watershed between the much lower broad basins of the Minnesota and Big Sioux rivers, and after this was withdrawn to its later limits at its inner moraine, extending from Spirit lake to Lake Shetek and Gary, a lower avenue was opened southward to the Little Sioux river. Without reference to this barrier, it is evident that the course of the waters that eroded these valleys was southwest, because of their extent and fall in this direction. The channel that reaches south from Lake Hendricks and then southwest descends from the summit, one and one-half miles south of the lake, with a very gradual slope which probably amounts to 75 or 100 feet in the next ten miles, its width continuing nearly the same as where it intersects the moraine. Another proof that the course of drainage was southwest is the confluence in this direction of the three valleys that cross this range at Lake Shaokatan, three miles farther northwest, and at Lake Hendricks.

On the other side of the moraine no well marked valleys extend northeastward from the lakes; and their outlets, which run only at unusually wet seasons, are turned in a meandering course by slight undulations of the surface. There seems to be no indication that the channels through the moraine have become partially filled since their excavation, raising them to their summits, 15 feet more or less, above Lakes Benton, Shaokatan and Hendricks; while yet the position and form of these lakes demonstrate that the portions of the drift-sheet which would have filled their depressions. were carried away by the rivers that cut these gaps. Now it is clear that the overflow from a lake lying between the ice-sheet and its moraine could not excavate a hollow several miles long below a summit which it afterward crossed. Respecting the possible action of subglacial rivers we have little knowledge, but it appears improbable that they could erode such hollows, carrying the material forward through higher channels. It is, however, nearly certain that this removal of the drift belonging upon the areas occupied by these lakes took place while the ice-sheet still covered these areas and reached to its terminal moraine: but near the end of this time when a warmer climate was rapidly melting its surface every summer, pouring down large rivers to its margin. By such melting, the drift which had been gathered into the ice-mass would become exposed upon its surface, and in and near its principal avenues of drainage would be washed away. Only in this manner could the material of the drift-sheet corresponding to the depressions of these lakes, be removed by the usual agency, that is, by the current of descending streams. If this be the true explanation, it involves a very important conclusion respecting the amount of drift contained in the ice-sheet and finally exposed by the melting of its surface. Modified drift and kames, as also certain features of the till and of the terminal moraines, prove that the ice of the glacial period became considerably filled with the material of the drift, gathered up into its mass from the land over which it moved.

Our last explanation of the origins of these lake basins indicates that the ice-held drift here amounted to a sheet at least 40 feet thick; but much of it may have been in the lower 150 feet of the ice, below the top of its terminal moraine.

In Dakota the continuation of this outer belt of knolly and hilly drift has been traced north-northwest through northeastern Brookings county, the center of Deuel county, southwestern Grant county and the northeast corner of Codington county. Its width is from two to three miles. North from Gary the nearly parallel inner moraine, very roughly broken upon a width that varies from one to two miles, is divided from this western moraine, as was stated on a preceding page, by a width of three or four miles which has a rolling surface but is much smoother in its outlines and slopes than these specially knolly belts. The inner or eastern moraine is generally from 100 to 200 feet above the foot of the slope on which it lies. This ascends some 250 feet more in the interval between this and the outer or western moraine, which lies between about 500 and 650 feet above the base of this slope, and approximately between 800 and 950 feet above the Minnesota river and Big Stone Lake. At the west side of the outer moraine in northern Deuel county and northward after a descent of 20 to 40 feet a smooth surface of slightly undulating till succeeds, and within a few miles rises 30 to 50 feet, and in some portions 75 feet, above the highest hillocks that were heaped at the margin of the ice-sheet, this watershed being from 1000 to 1050 feet above the Minnesota river or about 2000 feet above the sea. The material of these moraines is till with many boulders; and their contour is as usual, in many small hills, ridges and irregular hollows.

The outer moraine crosses northeastern Brookings county from sections 15 and 16, T. 111, R. 47, to sections 1 and 2, T. 112, R. 48. The southwest end of lake Hendricks and Oak lake lie in the east part of this belt. In Deuel county it first extends north through the east third of Ts. 113 and 114, R. 48, and thence passes northwestward to the county line at the north side of sections

1, 2, and 3, of its northwest township. Clear lake, the Coteau lakes, and the North Two Woods lakes lie at its west side, the last being in the depression between this belt of drift hills and knolls and the higher smooth surface of till three miles farther northwest. In crossing Deuel county from east to west on the Winona & St. Peter (C. & N. W.) railroad, the traveler enters the inner morainic belt at the west edge of Minnesota, a little east of Gary. This line crosses this belt obliquely, occupying about four miles, and the next six miles, lying partly on each side of Altamont, are among the knolls and small hills of the outer moraine, succeeded by a smooth, slightly undulating area of till, which rises to the summit of this line near Goodwin, 2000 feet above the sea, extends thence nearly level to Kranzburg, and then descends 250 feet by a very gradual slope to Watertown. Several lakes occur between these moranic belts in Deuel county, the largest being Lake Alice, two miles north of the railroad.

In southwestern Grant county and the northeast corner of Codington county, the west border of the outer moraine extends from section 34, T. 118, R. 50, to the southwest corner of section 30, T. 119, R. 50, and thence passes more westerly to sections 36 and 25, T. 120, R. 52. A lake two miles long lies at the southwest side of this knolly belt in T. 118, R. 50, and Punished Woman's lake lies within its limits seven miles farther northwest, in the northeast township of Codington county. The line of inner moraine in Grant county reaches from section 31, T. 118, R. 48, northwesterly to sections 33 and 34, T. 120, R. 50.

The farther extent of this formation forty miles north-northwest to the head of the Coteau des Prairies, twenty-five miles west of Lake Traverse, has not been explored. The land on which it lies is conspicuously seen from the east, as it maintains a continuous height about 2000 feet above the sea, or 1000 feet above Big Stone lake, Brown's valley, and Lake Traverse. Within a few miles north from the head of the coteau, the land in the northwest part of the Sisseton and Warpeton reservation falls 600 feet to the lowest portion of the watershed between Brown's Valley and the Sheyenne river.

THE MEDIAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO TURTLE MOUNTAIN.

It seems quite probable that a morainic belt of knolly and hilly drift, several hundred feet lower than this most elevated northwestern portion of the Coteau des Prairies, continues in the same north-north-west course between the Sheyenne and James river, or in part east of the Sheyenne, to the Devil's lake (Mini-wakan), a distance of 175 miles. Nicollet crossed the area between these rivers near latitude 46°, 30, about 60 miles northwest from the head of the coteau, and remarks that its highest portion "may be considered as a continuation of the Coteau des Prairies." He states that in approaching Devil's lake from the southeast, on the east side of the Sheyenne river, the highest of the hills at its south side, called by the Sioux *Mini-wakan-chante*, "the heart of Devil's lake," could be seen at a distance of more than thirty miles. "The lake is on the plateau of the Shayen-oju [Sheyenne river], and is surrounded by swells and hills, varying in height from twenty to 250 feet........The lake itself is so filled up with islands and promontories, that, in traveling along its shores, it is only occasionally that one gets a glimpse of its expanse."[*]

Turtle Mountain, which is crossed by our national boundary 75 to 100 miles northwest from Devil's lake, appears to be a portion of the same morainic series. Of this "Mountain" Mr. George M. Dawson writes: "It is a broken, hilly, wooded region, with an area of perhaps twenty miles square, and slopes gradually upward from the plain around it, above which it is elevated, at its highest points, about 500 feet. .... Nearly all the abrupt slopes and ridges in Turtle mountain—of which there are many—show boulders in abundance, and these appear to be chiefly of Laurentian rocks. .... The western is more abruptly hilly than the eastern side, and the more prominent ridges have a general northerly and southerly direction with intervening valleys .characterized by swamps and lakes. Large areas of comparatively level, or only gently undulated ground, are however found in some places. The surface of the 'mountain' appears to be that of the drift, as deposited, and has been but little modified by subsequent sub-aerial action. The lakes lie in basin-like hollows, and notwithstanding their great number, drainage valleys and stream courses are few and unimportant."[†]

Capt. W. J. Twining says: "From Turtle Mountain to the southeast, there is a series of rough hills, with intervals of rolling prairie, extending to Devil's lake, and thence to Lake Jessie, forming with the Coteau of the Prairie, on the western border of Minnesota, a line of drift formation almost exactly parallel and similar in character to the Coteau of the Missouri."[*]

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[*] Nicollet's Report on the upper Mississippi river, 1843 ; pp. 47 and 50.

[†] Dawson's *Report on the Geology of the Forty-ninth Parallel* ; Montreal : 1875 ; pp 223 and 224.

The principal masses of morainic drift which are found rising in prominent hills in or near the line of continuation of this formation to the north and northwest, occur in ranges which extend from east to west or from northeast to southwest. These include the Blue hills, stretching about 75 miles east from the lower part of the Souris or Mouse river, and the ranges of the Little Touchwood hills and the Touchwood hills north, of the Qu'Appelle river. Of the last Prof. H. Y. Hind writes: "The general direction of the range is N. 26° E. It appears to consist of a series of drift hills, many of which rise in rounded dome-shaped forms from the summit plateau," which is stated to have a width of four miles and an elevation about 500 feet above the prairie on the west, while its highest point, Heart hill, is some 700 feet above the plain eastward.[†]

If any of these morainic deposits northward from the head of the Coteau des Prairies were accumulated at the same time with the outer terminal moraine, which crosses southwestern Minnesota, they must be of medial origin, having been heaped where converging ice-currents were pushed against each other from the northeast and northwest, belonging to two vast lobes of the ice-sheet. The U-shaped moraine gathered at the margin of that which lay on the east, has been already described. It reaches from the head of the Coteau and from the Leaf hills south to central Iowa. The contemporaneous terminal moraine that marks the border of the second of these ice-lobes, lying on the west, extends from the head of the Coteau des Prairies about 150 miles southward on the west side of the Big Sioux river, then bends west across the lower part of the James river, and beyond turns to the north-northwest and northwest, crossing Dakota diagonally between the James and Souris rivers on the east and the Missouri river on the west, where it forms the conspicuous belts of knolly and hilly drift of the Coteau du Missouri.

THE TERMINAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO THE COTEAU DU MISSOURI.

The course of the moraine accumulated at the east border of this western lobe of the ice-sheet has been mapped for me in Codington and Hamlin counties by Mr. C. C. Wiley, land agent at Watertown, Dakota. He describes the formation in these counties as averaging about one mile in width, its material being till with abundant boulders, and its surface broken with many short ridges and hillocks, very irregular in their arrangement and variable in height, the most conspicuous being about 100 feet above the adjoining country. In general features this belt of hilly drift west of the Big Sioux is stated to be nearly the same with the morainic belts, which are crossed in Deuel and Grant counties, in going from Watertown east to Canby, or northeast to Big Stone City and Ortonville. The peculiar knolls and small hills of these moraines are almost universally called "coteaus;" and the belts occupied by them are very noticeable and unmistakable because of their rough topography and inferior agricultural value, in comparison with the smoothly undulating sheet of till which covers the remainder and much larger part of this region. Mr. Wiley reports that this moraine enters Codington county from the Sisseton and Warpeton reservation at the north, in the west edge of T. 119, R. 53, passing Indian lake, rising most prominently at the west side of section 31 of this township, and continuing two miles farther to the lake at the south side of Sec. 7, T. 118. R. 53. Through the next three or four miles this formation is inconspicuous, but regains its usual rough contour in Secs. 35 and 36 of T. 118, R. 54, and thence extends with a course a little east of south to the west ends of Lake Kampeska and Pelican lake, and thence south 3½ miles to the north line of Hamlin county. Its highest elevations occur is Sec. 13, T. 117, R. 54, one to two miles north of the west end of Lake Kampeska; south of this lake, in Secs. 5 and 6, T. 116, R. 53, lying six miles west of Watertown, and in the S. E. ¼ of Sec. 19 of the same township. From Sec. 13, T. 117, R. 54, a branch series of the drift hills extends three miles west and then seven miles northwest, bordered by several lakes on each side and ending in Secs. 26 and 23, T. 118, R. 55, at the west side of the largest of these lakes. The road from Watertown to the James river follows nearly the course of this range, which may be a medial moraine. In Hamlin county the course of this formation is first southeast through Secs. 4, 10 and 14, T. 115, R. 53, then south from section 23 of this township to Sec. 26, T. 114, R. 53, next south-southwest about three miles, and lastly south-southeast five miles, lying at the east side of three lakes, in T. 113, R. 53, and reaching the county line at the southeast corner of this township, at the southwest end of Lake Poinsett.

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[*] *Report upon the Survey of the Boundary of the United States from the Lake of the Woods to the Rocky Mountains.* 1870; p. 72.

[†] Hind's *Report of the Assiniboine and Saskatchewan Exploring Expedition;* Toronto: 1859; p, 68.

Southward the peculiar "coteaus" of this formation continue, as described to me by various travelers, in a course a little to the aast of south about 40 miles, with a width of from two to five miles, passing a few miles east of Nordland in southwestern Brookings county, through the northeastern border of Lake county, and into southwestern Moody county. Thence the series appears to bend southwest and west through the northwest edge of Minnehaha county. A range of these drift hills which is reported in T. 106, R. 55, at the west side of Lake county, is probably of medial origin. Of the farther course of this moraine, perhaps south through McCook and Turner counties and the north part of Yankton county, no definite information has been obtained.

THE COTEAU DU MISSOURI.

At the west side of this great lobe of the ice-sheet, its terminal deposits constitute the most broken portion of the Coteau du Missouri, generally forming its line of watershed. A second morainic belt appears also to be described 30 or 40 miles further west, lying at a distance of ten miles, more or less, east from the Missouri river. A part of this formation extending about twenty miles north-northwesterly in northern Aurora county and southeastern Hand county, lying about 30 miles west of Huron, has been named the Wesington hills.

Nicollet crossed the Coteau du Missouri in a northeast direction from Fort Pierre to the James river near the south line of Brown county, about west of Ortonville. On this route, within a few miles from the Missouri, its bluffs rise about 500 feet, attaining a height between 1900 and 2000 feet above the sea. The upper portion of these bluffs and the surface thence all the way to the James river, is reported to be drift. About 15 miles east of Fort Pierre, in the vicinity of East Medicine Knoll creek, a morainic area appears to have been crossed, respecting which Nicollet writes: "It is to be remarked of the prairies of this region, that they present low, insulated hillocks, to which the Sioux apply the somewhat generic name of *re* or *pahah*, according as they are more or less elevated above the surrounding plain. ....

Before quitting the forks of East Medicine river we had made an ample supply of water and wood; a necessary precaution, for soon every appearance of running water disappeared. The green plains regain their uniformity, bounded only by the horizon, and presenting a smooth surface, without one sprig of grass higher than another. The deep furrows made by the buffaloes in their migrating excursions from north to south and from south to north, are the only irregularities of the surface. However, as the direction of our route is towards the eastern border of the plateau, we could not help remarking that there the undulations of the prairie are shorter, their intervals deeper, and finally swell into hills of 80 to 100 feet in elevation. We had then reached the dividing ridge between the waters that empty into the Missouri and those that flow into the river Jacques" [near the northwest corner of Hand county, 40 miles northeast from the knolly tract first crossed]. "The mean elevation of this ridge above the sea, is 2,100 feet, and goes to 2,200 feet, if the mean height of the hillocks formed of the erratic deposit be taken into the estimate.................A few miles farther east we reached the extreme verge of the eastern limit of the Coteau du Missouri, whence a most magnificent spectacle presents itself, extending over the immense hydrographical basin of the Tchan-sansan, or river Jacques [James],............ The basin of the river Jacques between the two coteauu" [in latitude 45° 15', near the south line of Brown county] "may be laid down as having a breadth of 80 miles, sloping gradually down from an elevation of 700 to 750 feet,"[*]

Prof. Cyrus Thomas describes the Coteau des Prairies as divided southward into two arms, of which the western "encroaches close upon the James river valley, about latitude 44° 15', where it ends; the other arm reaches southeast, passing down on the east side of the headwaters of Big Sioux and gradually fades out in the southwest corner of Minnesota...............The other plateau is the Coteau of the Missouri. This hugs the valley, and follows the course of the Missouri northward from Fort Sully" [15 miles below the mouth of the Cheyenne river] "to the great bend of the river near the mouth of the Yellowstone. Here it recedes and extends in a northwest direction into British Possessions, where it gradually fades out and is lost. It varies in width from thirty to fifty miles, and in height from 1,800 to 2,200 feet above the sea; but the surface is more irregular than that of the other coteau, portions of it rising as much as 200 feet above the general average. The general elevation corresponds very closely with that of the Coteau des Prairies, showing very clearly some relation between the two. On each are numerous small lakes, mostly impregnated, more or less, with saline matter, and at many points on each, boulders are quite plenty." [†]

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[*] Nicollet's *Report on the Upper Mississippi*, 1843, pp. 44—46.
[†] *U. S. Geol. Survey of the Territory*, 1872, p. 294.

Dr. F. V. Hayden writes or the drift deposits, evidently morainic, which cover portions of southeastern Dakota, and of the Coteau du Missouri, as follows: "North of the Missouri river, from the Big Sioux river to Fort Clark" [40 miles north of Bismarck], "there are districts where one might walk for miles across the plains and over the hills, without stepping upon the ground, so closely paved is it with worn or partially worn boulders."[*]

On the line of the Northern Pacific railroad the Coteau du Missouri is composed of till with frequent boulders, and has a rolling surface with many lakes, but does not rise in prominent hills. Its height is from 1800 to 1900 feet above the sea, the James river on the east being 1400, and the Missouri river on the west, 1650.

Gov. Isaac I. Stevens traversed the Coteau du Missouri from the west side of the loop of the Souris or Mouse river in Dakota westerly to Fort Union at the mouth of the Yellowstone and west line of this territory. "The distance from Mouse river to Fort Union, as traveled, was 118¼ miles. The route crosses the Grand Coteau, a collection of high, stony and barren knolls, with great numbers of small ponds lodged between the hills. .... The general elevation is between 2,000 and 2,500 feet, and it descends again at the Missouri (Fort Union) 2,019 feet. .... The plateau between the Missouri and Mouse river, cannot be called simply a rolling prairie, though in detail resembling the hilly prairies noticed, although in a very exaggerated degree, having a general similarity of outlines, an absence of wood and rocks in place, boulders plentiful, ponds and marshes, if possible, more frequent; but the elevations are so much greater as to form considerable hills and ridges several hundred feet high, which become still more rugged on the approach to Fort Union, where they end abruptly on the level intervale of the Missouri."[†]

Mr. George M. Dawsan, geologist of the British Boundary Commission for establishing the line between the United States and British America from Lake of the Woods to the Rocky Mountains, gives an admirable description of this belt of roughly hilly drifts, where it passes beyond our national limits at the northwest corner of Dakota, 120 west of Turtle Mountain. "The Missouri Coteau is one of the most important features of the western plains, and is certainly the most remarkable monument of the glacial period now existing there. I have had the opportunity of examining more or less carefully that portion of it which crosses the forty-ninth parallel, northwestward for a length of about 100 miles. On the parallel, the breadth of the Coteau, measured at right angles to its general course, is about 30 miles; and it widens somewhat northward. On approaching its base, which is always well defined at a distance, a gravel ascent is made, amounting in a distance of 25 miles to over 150 feet. The surface at the same time becomes more remarkably undulating, as on nearing Turtle Mountain from the east, till almost before one is aware of the change, the trail is winding among a confusion of abruptly rounded and tumultuous hills. They consist entirely of drift material; and many of them seem to be formed almost altogether of boulders and gravel, the finer matter having been to a great extent washed down into the hollows and basin-like valleys without outlets with which this district abounds. The ridges and valleys have in general no very determined direction; but a slight tendency to arrangement in north and south lines was observable in some places. .... Taking the difference of level between the last Tertiary rocks seen near the eastern base of the Coteau, and those first found on its western side, a distance of about 70 miles, we find a rise of 600 feet .... On and against this gently inclined plane the immense drift deposits of the Coteau hills are piled. The average elevation of the Coteau above the sea, near the forty-ninth parallel, is about 2,000 feet; and few of the hills rise more than 100 feet above the general level. .... From what I can learn of this region it would appear that the so-called Coteau des Prairies and Coteau de Missouri, between which a distinction is made on the maps, are parts of the same great feature. Their elevation is similar, and nearly the same as that of the Coteau on the line; and they are equally characterized by the immense profusion of erratics with which they are strewn, and by basin-like swamps and lakes. The Coteau des Prairies, however, stretches furthest, and dies away only in the southwestern corner of Minnesota. In the Coteau, then, we have a natural feature of the first magnitude, a mass of glacial debris and traveled blocks, with an average breadth of perhaps 30 to 40 miles, and extending diagonally across the central region of the continent for a distance of about 800 miles."

[†] Report of same, 1870, p. 174. These quotations are cited by Mr. G. M. Dawson, in connection with his description of the Coteau du Missouri in the vicinity of the 49th parallel

[*] *Reports of Explorations and Surveys for a Railroad from the Mississippi River to the Pacific Ocean made in* 1853-5; 1860. Vol. xii, Book i. pp. 84 and 85.

In British America, between the 49th and 50th parallels, a plateau of Tertiary strata, higher than these drift deposits, rises at their southwest side, its slope near the border of the Coteau being characterized by lakes or chains of lakes, which "have a winding river-like form, and fill steep-sided valleys. These great old valleys have now no outlet; they are evidently of preglacial age, and have formed a part of the former sculpture of the country. The heaping of the great mass of debris of the Coteau against the foot of the Tertiary plateau has blocked them up and prevented the waters from finding their way northward as before ; and since glacial times the rainfall of the district has never been sufficiently great in proportion to the evaporation to enable the streams to cut through the barrier thus formed. The existence of these old valleys, and the arrangement of the drift deposits with regard to them, throw important light on the former history of the plains. Northward the Coteau ceases to be identified with the Tertiary plateau, and rests on a slope of Cretaceous rocks. It can be followed by Palliser's and Hector's descriptions of the country to the elbow of the South Saskatchewan, and thence in a line nearly due north through the Eagle and Thickwood hills" [the former lying at the west side of the South Saskatchewan below its elbow, and the latter north of the North Saskatchewan, about 75 miles west of the junction of these rivers and 300 miles west of Lake Winnipeg]; "beyond the North Saskatchewan, however, it appears to become more broken and less definite. In Dr. Hector's description of certain great valleys without outlet in this northern region, I believe I can recognize there too the existence of old blocked-up river-courses similar to those just described."*

It appears that north of latitude 50° this formation consists, as in Freeborn county and upon the Coteau des Prairies in southwestern Minnesota, of two nearly parallel ranges or belts of knolly and hilly drift. Besides this series of drift hills of Dawson's report and map, west of the South Saskatchewan river, or South Branch, between its elbow and its confluence with the North Branch, another morainic belt occurs at its east side along this distance, of which Prof. H. Y. Hind writes as follows: "A continuation or spur of the Grand Coteau comes on the Qu'Appelle river at the height of land about 18 miles [east, southeast] from the elbow of the South Branch. Here it is called the 'Eyebrow Hill Range' by the Crees. . . . . The South Branch flows for fully 200 miles from the elbow at the foot of this continuation of the Eyebrow Hill Range, in a northerly direction, and its deep excavated valley appears to lie at an average distance of twelve miles from it. This range is cut by several narrow deep valleys ; and from the small lakes or ponds which occupy their summits, water, during spring freshets, flows to the Saskatchewan and Assiniboine. .... It appears to terminate suddenly in the form of an isolated hill about 400 feet above the plain, called 'The Lumpy hill of the Woods.' .... From its summit an undulating open country, dotted with lakes and flanked by the Birch hills is visible towards the east. South and southwest is a lake region, also north and northeast. These lakes are numerous and large, often three miles long and two broad. Seventeen large lakes can be counted from the Lumpy Hill ; hill ranges in several directions can also be discerned. The most important of these are the Bloody hills, the Woody hills, far in the prairie west of the South Branch, and the chain of the Birch hills running from the Lumpy hill [north-]easterly. .... This eminence consists of drift sand and clay, with boulders on its summit."[*]

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* G. M. Dawson, in *Quarterly Journal Geol. Soc.*, for Nov., 1875, vol. xxxi, pp. 614--616 ; and more fully in *Rep. on Geol.* on the Forty-ninth Parallel, 1875, pp. 227—237.

The origin of the morainic range of the Touchwood hills, briefly described on a preceding page, seems very probably to have been as a medial branch about 150 miles in length, diverging northeasterly from the Coteau du Missouri at about 40 miles south of the Eyebrow hill and the head of the Qu'Appelle river. Twenty-five miles east-southeast from the Eyebrow hill, the Qu'Appelle intersects this belt of drift hills at the head of Buffalo Pound Hill lake. Prof. Hind says: "The whole country here assumed a different appearance; it now bore resemblance to a stormy sea suddenly become rigid; the hills were of gravel and very abrupt, but none exceeded 100 feet in height. The Coteau du Missouri is clearly seen from Buffalo Pond Hill towards the south, while northeasterly the Last Mountain of the Touchwood Hill range looms gray or blue in the distance. Between these distant ranges a treeless plain intervenes."[†]

THE BLUE HILLS AND THE MESABI RANGE.

The Blue hills of the Souris, extending 75 miles east from the northwest side of the Souris or Mouse river near its mouth, about 30 miles north of Turtle Mountain, to the escarpment called Pembina mountain, which forms the west boundary of the plain of the Red river valley, appear to be part of a terminal moraine, accumulated at the front of the ice-sheet during a halt in its retreat, perhaps attended by some readvance, long after it had withdrawn from the Coteau of the Missouri and the Coteau of the Prairies.

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[*] *Report of the Assiniboine and Saskatchewan Exploring Expedition*, 1859 ; pp. 27, 28, 67 and 68.

[†] Same report, p. 53.

The Mesabi range of drift hills in northern Minnesota,[*] reaching from Winnebigoshish and Bowstring lakes easterly to the sources the St. Louis and Vermilion rivers, and thence east-northeast upon a region which has frequent exposures of the bed-rocks, sometimes in more conspicuous hills than those of the drift, is believed to be another part of the terminal moraine. The topographic features of these series of drift deposits indicate this origin; and their geographic position makes it probable that they are contemporaneous with each other, and certain that they are more recent than the terminal moraine which extends from the coteau to Mineral Ridge in Iowa, thence northward to the Leaf hills in Minnesota, and from there east and southeast to the Kettle Range in Wisconsin. Professor Hind states that the Blue hills of the Souris are composed of drift derived chiefly from the Cretaceous rocks which underlie that region, and their height is marked on his map as from 50 to 500 feet, the valley that the Souris has cut through the range being 350 feet high.

MODIFIED DRIFT AND LOESS.

When the ice-sheet extended to the Coteau du Missouri, the Coteau des Prairies, and the Kettle moraine, the floods formed by its summer meltings were carried southward by the present avenues of drainage, the streams which occupied the areas between its great lobes in order from west to east being the Big Sioux, Mississippi, and Wisconsin rivers. The vast glaciers which were gathered upon the Rocky mountains, and the ice-fields which sloped downwards to their termination at the coteaus and the moraine north and east in Minnesota and Wisconsin, supplied every summer immense floods laden with silt, sand, and gravel, that had been contained in the melting ice. Very extensive deposits of modified drift were thus spread along the course of the swollen Missouri and Mississippi. The Orange sand and gravel, described by Prof. E. W. Hilyard and others in the lower Mississippi valley, appear to have been deposited in this way, but during the earlier glacial epoch when an ice-sheet reached in Dakota beyond the Missouri river to a termination 40 miles west and 20 miles southwest of Bismarck,[†] into northeastern Kansas, half way across the State of Missouri, and nearly to the Ohio river.

In the closing stages of this epoch and during the time succeeding till the date of the terminal moraine of the Coteaus and especially at the final retreat of the ice-sheet of this later epoch, the deposition of the overlying, finely pulverized, arenaceous and calcareous silt, called the Bluff formation or Loess, took place. This covers considerable areas along the Mississippi from southeastern Minnesota to its mouth; but its greatest thickness and extent are found in the basin of the Missouri river from southern Dakota to its junction with the Mississippi, and upon the region crossed by the Platte or Nebraska river, its longest tributary from the west, which takes its headwaters from a large district of the Rocky mountains. The continuity of this formation from the borders of the ice-sheet and the glaciers of the Rocky mountains to the shores of the Gulf of Mexico, the absence from it of marine shells, and the presence of land and fresh water shells, indicate that its deposition was by slowly descending floods, uplifted upon the surface of this sediment which was being accumulated during every summer through a long epoch, in the same manner that alluvium is now spread upon the bottom lands of our rivers at their times of overflow. The occurrence of the loess in Guthrie, Carroll, Sac, and Buena Vista counties in Iowa, covering the region next west of the terminal moraine, with its surface 50 feet above these drift hills and 100 feet above the undulating area of till adjoining their east side, proves that during the time of deposition of this part of the loess the ice-sheet extended to this limit and was a barrier preventing the waters by which this sediment was brought from flowing over the lower area of till that reaches thence east to the Des Moines river. When the the ice-sheet retreated beyond the watershed of the Missouri basin, the principal source of these floods and their sediment was removed, and the subsequent work of the rivers which cross the area of the loess has been to excavate their present valleys or channels, bounded by bluffs of this formation.

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[*] Seventh An. Rept. Geol. and Nat. Hist. Survey of Minn. for 1878, p. 12; and Col.C. Whittlesey's Report on Mineral Regions of Minnesota, 1866 ,pp. 8 and 44.

[†] Prof. N. H. Winchell's Report to Capt. Ludlow, on *Geology of the Black Hills of Dakota*, 1875; pp. 22 and 60.

RECESSION OF THE ICE-SHEET.

The departure of the ice-sheet appears to have taken place by melting which affected large areas of its surface, causing the ice to disappear from wide districts without leaving upon them any deposits pushed out at its border or accumulated at lines where opposing ice-currents met. Anon a colder epoch causes the thickness and extent of the ice-fields to increase again, and another terminal moraine is formed at its margin. In Minnesota, Iowa, Dakota and British America, the first halt or readvance is marked by the inner morainic series which appears east of the South Saskatchewan; in the east belt of drift-hills upon the Coteau of the Missouri; and, as traced by the writer, on the Coteau of the Prairies from Grant county in Dakota, through southwestern Minnesota, and at least to the south line of Palo Alto county in Iowa, and on the east side of this lobe of ice-sheet from Rice county in Minnesota, southward through Waseca, Steele and Freeborn counties in this State, and Winnebago, Hancock and Wright counties in Iowa. This inner moraine is from two to twenty-five miles distant from the outer approximately parallel moraine. The courses of drainage which were now taken by the waters that flowed from the ice-border were nearly identical with those of the present time on the east side of the great ice-lobe which reached from Minnesota to central Iowa. On its west side the drainage from the Coteau des Prairies, between the morainic belts, including the sources of the Des Moines river in Murray county, and the waters of Heron lake and its tributaries, went southward by the Little Sioux to the Missouri river, instead of going southeast, as now, by the Des Moines to the Mississippi. Thence northwest to the British Possessions, there was an unobstructed descending slope southward from the margin of the ice-fields; but a lake filled the valley of the South Saskatchewan, west of the Eyebrow Hill range and the Lumpy Hill of the Woods,[*] because in the direction of descent of this valley the ice-sheet was a barrier. The outflow of this lake where the ice-sheet terminated at the Eyebrow Hill range and the inner morainic belt of the Coteaus, was doubtless southward to the Missouri.

Again a more genial climate prevails, and when it is next interrupted by a cold epoch and the formation of another conspicuous series of drift-hills, the outlines of the ice-sheet are greatly changed. From southeast Dakota its border has receded to the north 400 miles, and lies beyond our national boundary at the Blue Hillis of the Souris. The region through which the Assiniboine flows, and the lower part of that crossed by its tributary, the Qu'Appelle, were still deeply covered by the ice which probably terminated westward near the Last Mountain and Touchwood hills, the Birch hills and the junction of the North and South Saskatchewan. From central Iowa the ice-front had also retreated 400 miles to the Mesabi range in northern Minnesota. Three-quarters of this distance was the vast glacial tongue or lobe which stretched from the Leaf hills to the vicinity of Des Moines, bounded by a land surface on the west to the head of the Big Sioux river, and on the east to the Leaf hills. During the disappearance of these vast areas of ice, the rivers which flowed from them were swollen to floods like the largest which, in exceptional years, accompany the sudden melting of the accumulated snows of winter. These last only a few days, but at the departure of the ice-sheet it is evident that such floods were prolonged through the entire summers of a long period of years. The abundant deposits of drift, both stratified and unstratified, that took place during the final melting of the ice, has been brought into due prominence by Prof. James D. Dana, who denominates this the champlain period. Much of the drift which had been contained in the glacial sheet was now dropped without being transported or assorted by water, and forms the upper part of the till. The remainder of this drift was removed by the streams that descended from the surface of the melting ice-fields, and its coarser portions were partly deposited in the channels of these glacial rivers, walled upon each side by ice, which afterward melted. leaving the ridges and mounds of interbedded gravel and sand called kames. These are generally inconspicuous in Minnesota, and from no long series such as have been described in the eastern States. The finer gravel and sand were mostly borne beyond the ice-margin, and were soon deposited, often with a more or less undulating surface, sometimes forming swells or low hills, but more generally in nearly flat plains of considerable extent, sloping a few feet per mile in the direction of the currents of the descending floods by which they were carried. Such beds of modified drift cover considerable portions of the basin of the upper Mississippi, from Minneapolis and Anoka county north to the Northern Pacific railroad, and to the lakes through which this river flows near its source. Along this distance the present channel has been excavated from 30 to 75 feet deep below the flood-plain which was overspread during every summer by the waters supplied by glacial melting in this epoch. The finest silt and clay were carried farthest, being partly deposited in spaces of nearly still water along this upper valley, but also adding largely to the loess along the whole extent of the river below.

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[*] Prof. H. Y. Hind's *Report of the Assiniboine and Saskatchewan Exploring Expedition*, p. 118.

Lakes were formed at many places by this great recession of the ice-sheet, where they have long since disappeared. either by cutting their outlets so deep that they were emptied, or by the removal of the ice-sheet which during its retreat northward formed the barrier by which they were enclosed. The most notable of the first class appears to have occupied the valley of the James river at Jamestown, until its overflows cut the deeply excavated channel through which this river flows in southeastern Lamure and Brown counties. During the time of this erosion the volume of water flowing here was greatly augmented by glacial melting, and cut a deeper channel than the present diminished river has maintained, the silt since brought down by tributary streams having formed dams by which the river is changed to a series of long shallow lakes in these counties. A lake of the second class, held by the barrier of ice, covered the greater part of the basin of the Blue Earth river in Southern Minnesota. gradually extending north from the watershed at the south side of this basin, until the melting of the ice-sheet on the area crossed by the Minnesota river below Mankato allowed drainage to take its present course. The extent of this lake is indicated by the very smooth and flat surface of the till, which is imperfectly stratified in many places, on the greater part of Faribault, Blue Earth, and southwestern Waseca counties. Its outlet is found in Kossuth county, Iowa, at the head of the most southern branch of the Blue Earth river. where Union slough occupies a continuous channel from the headwaters of the Blue Earth to Buffalo creek and the East Fork of the Des Moines. It is stated that at time of high water an uninterrupted canoe voyage has been made by this route from Algona on the East Des Moines river north to Blue Earth City. This glacial channel is about eight miles long. extending in a southerly course ; and its width is from one-eighth to one-fourth mile, with enclosing bluffs which rise steeply 20 to 30 feet to the general surface of moderately undulating till on each side. Its bottom along the Union slough, where its descent was southward, is now mainly occupied by a marsh, because of the partial filling up of its continuation since the ice age.

During the epoch in which the ice-sheet was accumulating the terminal moraine of the Mesabi hills and the Blue Hills of the Souris river, the lake in the South Saskatchewan valley remianed, held by the ice-barrier on the north ; but it found a lower outlet than before at the divide between the River that Turns and the Qu'Appelle, 12 miles southeast from the elbow of the South Saskatchewan. A little farther east this outlet cut through the Eyebrow hill ridge, but its waters could not follow the present entire course of the Qu'Appelle, because the region of its lower portion and of the Assiniboine river were still covered by the ice-sheet. By this barrier the outflow from the Saskatchewan lake was turned south into the Souris or Mouse river, probably by the Souris Fork, tributary to the Qu'Appelle about 75 miles east, southeast from the head of this river and near the junction of its North Fork from Long lake. The Souris river was also turned by the ice-sheet in a different course from that which it now takes. At the time of melting and retreat of the ice from the Coteaus, a lake covered the smooth, low area through which the loop of this river flows west of the medial moraine of Turtle Mountain. This at first probably found an outlet east by the Big Coule and Sheyenne river; but when the ice-border retired to its terminal line at the Blue hills, it appears that this lake was emptied by the Souris river, which took its course as now north of Turtle Mountain. It could not continue, however, to its present mouth, but was turned, probably flowing through a lake, at the very front of the ice-sheet, and sent its waters, including those of the Saskatchewan lake, by the avenue of the Back Fat creek and lakes, to the Pembina river.* A feature which marks nearly every stream that was thus the outlet of floods supplied by glacial melting, after they had been freed from the greater part of their sediment by flowing through a lake, is that the channel then excavated has been since partially filled by the silt of its tributaries, holding back the waters of the present rivers, in long, narrow and usually shallow lakes. The Back Fat lakes, and Rock and Swan lakes on the Pembina river, illustrate this; so, too, Lake Traverse, Big Stone lake and Lac qui Parle, in the valley which was the outlet of Lake Agassiz; and, still more notably, the lakes of the Qu'Appelle river.

The description, map, and section of the Qu'Appelle or Calling river and its bluffs, given in Professor Hind's valuable report, show that this valley is quite uniformly about one mile wide, and is from 110 to 350 feet below the general level of the region through which it lies, this height being reached by steep bluffs on each side. Its length, from the elbow of the South Saskatchewan to its junction with the Assiniboine is 268 miles, the general course being a little to the south of east. Of this extent the west end of the valley for 12 miles is occupied by the River that Turns, and the remainder by the Qu'Appelle, the summit or height of land in this channel at the divide between these rivers being 85 feet above the South Saskatchewan, and approximately 285 feet above the junction of the Qu'Appelle and Assiniboine rivers. The following table brings into view the remarkable topographic features of this valley, which is closely like that of the Minnesota river and Lake Traverse. Its alluvial bottomland appears to be from one-half mile to one mile wide, and through it the river flows in a winding course, here and there passing through long lakes. The enclosing bluffs are composed mainly of glacial till, with only a few exposures of the underlying Cretaceous rocks in this distance.

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* Hind's *Report*, pp. 118 and 168.

Section along the valley of the Qu'Appelle River.

LOCALITY.	Distances in miles fr'm mouth of Qu'Appelle river.	Approximate heights in feet above the sea.	Maximum depth of lakes in feet.	Aproximate height of bluffs in feet.
Mouth of Qu'Appelle river	....	1282	....	240
Round lake	41—46	1343	30	310
Crooked lake	57—62	1357	36	300-320 (p59)
First Fishing lake	108—114	1422	66	300-350(p144)
Second Fishing lake	115—118	1423	48	275
Third Fishing lake	119—124	1425	57	270
Fourth Fishing lake	124—133	1426	54	270
Lake	184—185	1504	about 15	185
Buffalo Pound Hill lake	194—210	1512	about 20	180
Sand Hill lake	240—244	1552	about 20	115—150
Height of land	256	1567	....	110—140
Ponds on the River that Turns	260—261	1549	about 10	110
Elbow of the South Saskatchewan river	268	1482	....	140

The east part of this valley and the Assiniboine valley which it joins were excavated after the ice-front had receded from its terminal moraine at the Mesabi and Blue hills, but apparently before its barrier was removed from the northeast end of the glacial lake in the Saskatchewan valley. The outflow of this lake, fed by the melting ice-fields of an immense area, reaching west to the glaciers of the Rocky Mountains, now took its course east by this singular, trough-like channel or valley, occupied to-day by the River that Turns and the Qu'Appelle, entering the Assiniboine at Fort Ellice, and reaching the border of Lake Agassiz near the mouth of the Souris river. The delta which this stream brought into Lake Agassiz forms a large area of sand hills and dunes, which extends 50 miles along the north side of the Assiniboine river next below the mouth of the Souris. During this time the ice-border lingered upon the highlands of the Riding or Dauphin Mountain, Duck Mountain, Porcupine hill and Pas Mountain at the west side of Manitoba, Dauphin and Winnipegosis lakes.

Step by step we have now followed the departing ice-sheet in its retreat from the terminal moraine of the Leaf hills and the Coteau des Prairies. For a time it had paused at the lines of the Mesabi and Blue hills; but when this delta was accumulated, it had again receded probably beyond the limits of Minnesota. Lake Agassiz, held by this glacial barrier, had gradually extended from the height of land in Traverse county at the west side of this state, covering the flat valley of the Red River of the North, and reaching east at the north side of the state, beyond this basin, over a considerable part of that of the Lake of the Woods and Rainy Lake river. With the farther recession of the ice, the west shore of this glacial lake was extended along the great terrace which had been eroded, probably before the ice age, in the Cretaceous strata, forming Pembina, Riding and Duck mountains, Porcupine Hill and Pas Mountain. These consist of drift at their summits, and apparently to a great depth, and they form, with the Lake of the Woods and Vermilion lake, a dividing line between a region on the southwest, which is distinguished by very thick drift deposits, averaging from 100 to 200 feet in thickness, with rare exposures of the older rocks, and a region on the northeast, which has a comparatively thin sheet of drift, with abundant outcrops of the bed-rocks. At length the ice-sheet was melted between Lake Winnipeg and Hudson Bay, causing Lake Agassiz to be drained in that direction. At first, however, this took place by a pass about 90 feet higher than the present outlet of this basin by Nelson river, as shown by the well marked beach ridges at this height in the valley of the Red River and near Lakes Winnipeg and Manitoba.*

ELEVATIONS.

The following series of elevations have been determined by railroad surveys within the district specially explored and described in this report. Unless otherwise indicated, they refer to the track or grade at the depots, summits and depressions of the railroads; and all are stated in feet above the level of the sea at mean tide. They are given as they were received or copied from the records and profiles of these roads, and a comparison of their points of intersection, and of the determinations of the height of rivers, shows that they are all quite near the truth. The limits of error are apparently less than ten feet for all, excepting the line west from Salem in southeastern Dakota, which is a preliminary survey, making the James river some twenty feet higher than the two other elevations of this river at points farther north require.

Respecting the heights of the terminal and medial moraines, which close this list, it should be borne in mind that these depos-

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*H. Y. Hind's *Report of the Assinniboine and Saskatchewan Exploring Expedition.* pp 39 and 40.

its vary in their elevation with the changes in the general altitude of the country which they cross. In most cases, their height is stated for a considerable area, as one or more counties; and their least and greatest elevations usually refer to different portions from twenty to fifty miles apart, between which there is commonly a gradual change in height, the topography of this region, excepting its moraines, being remarkably uniform and smooth.

Hastings & Dakota Division, Chicago, Milwaukee & St. Paul Railway.

Copied from profiles in the office of GEORGE H. WHITE, Engineer, Minneapolis.

	Distance in miles from Hastings.	Height in ft. above the Sea.
Low water in Mississippi River at Hastings	....	670.5
Hastings Junction with River Division	....	707.5
Glencoe	74.	1006.5
Sumter	79.9	1035 ....
Brownton	84.4	1024 ....
Stewart	94.1	1064 ....
Hector	102.4	1081 ....
Bird Island	111.6	1089 ....
Olivia	116.0	1082 ....
Renville	127.2	1064 ....
Sacred Heart	134.1	1061 ....
Hawk Creek, water	139.3	963 ....
Hawk Creek, bridge	139.3	1017 ....
Minnesota Falls	141.2	1041 ....
Granite Falls	143.3	941 ....
Montivideo	156.6	927 ....
Chippewa River, water	156.8	913 ....
Watson	162.9	1029 ....
Depression, grade	167.0	937 ....
Milan	171.7	995 ....
Summit, grade	177.1	1035 ....
Appleton	179.8	1007 ....
Pomme de Terre River, water	180.1	978 ....
Correll	186.9	980 ....
Odessa	194.3	963 ....
Ortonville	202.0	990 ....
Big Stone Lake, water	.....	962.5
Lake Traverse, water	.....	970 ....
Milbank Junction	214.0	1149 ....
Foot of Coteau des Prairies	222.0	1294 ....
Summit of Coteau des Prairies	236–236.5	1993–2003

Winona & St. Peter Division, Chicago & Northwestern Railway.

From JOHN E. BLUNT, Engineer, Winona.

a. MAIN LINE.

	Distance in miles from Winona.	Height in feet above the Sea.
Low water in Mississippi River at Winona	.....	639.9
Top of rail on draw bridge	.....	670.5
Winona	0.	649 ....

	Distances in miles from Winona.	Height in above the sea.
Minnesota City	5.9	676
Stockton	11.31	753
Lewiston	18.30	1211
Utica	22.74	1170
St. Charles	28.35	1139
Dover	32.19	1138
Eyota	36.87	1237
Chatfield Junction	37.73	1275
Plainview Junction	37.93	1275
Chester	42.74	1122
Rochester	49.26	991
R. & N. M. R'y Junction	50.64	999
Olmsted	54.22	1054
Byron	58.71	1250
Kasson	63.87	1252
Dodge Center	69.22	1288
Claremont	76.36	1280
Havana	83.90	1246
Owatonna	88.17	1144
Meriden	96.35	1149
Waseca	102.63	1153
Janesville	112.91	1063
Eagle Lake	122.56	1012
Mankato Junction	127.99	906
Mankato	131.00	781
Kasota	133.80	804
Minnesota River bridge	135.00	791
Minnesota River, low and high water	135.00	733–745
Saint Peter	136.19	812
Oshawa	146.29	982
Nicollet	150.88	980
Courtland	158.56	936
Minnesota River bridge	162.50	821
Minnesota River, high water	162.50	807
New Ulm	165.31	837
Siding	169.00	994
Sleepy Eye	179.72	1034
Redwood Falls	.....	1028
Springfield	193.18	1025
Sanborn	201.56	1089
Lamberton	208.77	1144
Walnut Grove	218.98	1223
Tracy	226.55	1403
Amiret	233.65	1283
Marshall	243.85	1174
Grand View	250.75	1173
Minneota	256.52	1179
Canby	274.03	1243
Gary	284.62	1484
Altamont	297.38	1834
Goodwin	305.90	1996
Kranzburg	309.53	1982
Watertown	319.10	1733
Sioux River, water	320.00	1709
Lake Kampeska, water	322.00	1714

b. BRANCH TO CHATFIELD.

Chatfield Junction	37.73	1275

	Distances in miles from Winona.	Height in feet above the Sea.	
Summit, grade	40.75	1295	....
Chatfield:	48.87	976	....

c. BRANCH TO PLAINVIEW.

Plainview Junction	37.93	1275	....
Doty	40.00	1310	....
Viola	43.00	1129	....
Whitewater Creek	47.00	1055	....
Elgin	48.17	1069	....
Plainview	52.93	1167	....

d. BRANCH TO ZUMBROTA.

R. & N. M. Junction	50.64	999	....
Douglass	58.35	1091	....
Zumbro River	60.25	966	....
Zumbro bridge	60.25	986	....
Oronoco	61.72	1041	....
Zumbro River	65.20	984	....
Zumbro bridge	65.20	993	....
Pine Island	65.86	998	....
Lena	70.66	1073	....
Forest Mills	73.14	1023	....
Zumbrota	74.56	971	....

e. DAKOTA CENTRAL RAILWAY.

Tracy	226.55	1403	....
Balaton	239.55	1528	....
Redwood River	246.60	1592	....
Redwood bridge	246.60	1631	...
Tyler	253.70	1750	....
Lake Benton	261.50	1759	....
Verdi	267.6	1771	....
Elkton	274.3	1851	....
Aurora	285.1	1630	....
Summit, grade	288.9	1683	....
Brookings	290.8	1636	....
Sioux River	296.4	1596	....
Sioux bridge	296.4	1607	....
Volga	297.4	1636	....
Nordland	308.3	1846	....
Lake Preston	317.3	1696	....
De Smet	329.6	1726	....
Summit, grade	331.4	1767	....
Fairview	338.3	1542	....
Iroquis	344.8	1401	....
Cavour	354.0	1311	....
James River	361.8	1228	....
James bridge	361.8	1270	....
Huron	362.9	1285	....
Huron Junction	366.9	1312	....
Pierre	482.0	1438	....
Missouri river	482.0	1424	....

Southern Minnesota Division; Chicago, Milwaukee & St. Paul Railway.

From GEORGE B. WOODWORTH, Assistant Engineer, La Crosse.

a. MAIN LINE.

	Distances in miles from La Crosse.	Height in feet above the Sea.
Low water in Mississippi River at La Crosse	.....	626.3
Junction with River Division, west of bridge	0	653
La Creseent	0.7	647
C. C. D. & M. Junction	3.0	641
Root River bridge	4.2	648
Hokah	6.2	649
Root River bridge	11.0	663
Mound Prairie	12.2	660
Root River bridge	14.0	669
Houston	18.7	679
Root River bridge	22.3	703
Money Creek	23.2	699
Rushford	29.9	722
Peterson	34.5	756
Whalan	43.4	786
Root River bridge	46.0	801
Root River bridge	47.5	824
Lanesboro	48.0	841
Root River bridge	51.7	873
Isinour's	53.6	899
Fountain	59.3	1302
Depression, grade	60.6	1259
Summit, grade	64.7	1330
Wykoff	66.5	1310
Summit, grade	68.5	1367
Spring Valley	73.6	1266
Summit, grade	80.1	1358
Grand Meadow	83.0	1338
Depression, grade	85.2	1317
Dexter	89.8	1412
Brownsdale	98.0	1271
Cedar river, water	102.9	1192
Ramsey, crossing Minnesota Div. of C. M. & St. P. Ry.	103.1	1214
Depression, grade	107.7	1197
Oakland	109.9	1265
Summit, grade	113.8	1270
Depression, grade	117.6	1241
Hayward	118.0	1248
Summit, grade	121.5	1263
Depression, grade	124.2	1206
Albert Lea	124.6	1221
B., C., R. & N. crossing	124.7	1220
Summit, grade	128.9	1323
Armstrong	129.8	1270
Summit, grade	133.5	1317
Alden	135.2	1261
Dood's Switch	139.7	1189
Wells	144.4	1153
Junction of Mankato branch	144.7	1145
Easton	153.3	1046
Summit, grade	157.1	1077
Delevan	159.2	1067
Depression, grade	159.5	1047
Crossing branch of St. P. & S. C. R. R. Co	166.1	1096
Winnebago City	166.3	1096

	Distances in miles from La Crosse.	Height in feet above the sea.
Blue Earth river, water	168.4	1014
Fairmont	183	1176
Sherburne	197.5	1273
Top of bluff at junction of branch to Jackson depot	209.1	1446
Des Moines river, water	211.8	1288
Des Moines river bridge	211.8	1353
Summit, grade	216.6	1517
Lakefield	220.6	1463
Okabena	229.1	1410
Crossing St. P. & S. C. R. R	232.2	1414
De Forest	239.5	1446
Fulda	246.1	1508
Iona	255.6	1608
Summit, grade	259.4	1705
Entering Chanarambie valley, grade	264.0	1634
Chanarambie creek, water at last crossing	274.5	1521
Edgerton	276.0	1550
Rock river	279.0	1552
Hatfield	283.0	1662
Highest point on road	285.5	1744
Pipestone city	289.0	1693
Pipestone creek, water	293.0	1577
Airlie	295.5	1629
Flandreau	303.6	1550
Big Sioux river, water	306.1	1495
Egan	308.0	1510
Sioux Falls Junction	309.9	1496
Summit, grade	315.0	1695
Summit, grade	328.5	1705
Summit, grade	330.6	1691
Madison Lake, 2 mi. S. of last	.....	1576
New Madison	332.6	1646
Herman	335.0	1654
Lake Herman	.....	1646
Summit of hills, approximately	342.0	1825
Top of bluff	342.2	1732
East Vermilion River, water	344.1	1607
Top of bluff	345.5	1694
Top of bluff	352.3	1583
West Vermilion River, water	354.0	1518
Top of bluff	360.6	1404
Rock Creek, water	360.9	1367
Top of bank	361.5	1392
Little Jim Flats	370.6	1293
Top of bluff	381.3	1266
James River, water	383.0	1195
Prairie west of James River	388.0	1260

b. BRANCH TO MANKATO.

Junction near Wells	144.7	1145
Minnesota Lake	153.0	1038
Mapleton	161.4	1031
Maple River, water	168.5	935
Good Thunder	169.3	974
Rapidan	175.6	979
Le Sueur River, water	177.9	772
Le Sueur River, bridge	177.9	825
Crossing St. P. & S. C. R. R	181.3	795

	Distances in miles from La Crosse.	Height in feet above the sea.
Mankato	182.5	770 ....
Minnesota River, water	.....	748 ....

c. BRANCH TO SIOUX FALLS.

Sioux Falls Junction	309.9	1496 ....
Big Sioux River, water, second crossing	310.7	1479 ....
Big Sioux River, water, third crossing	315.8	1461 ....
Dell Rapids	322.7	1467 ....
Big Sioux River, water, fourth crossing	323.0	1452 ....
Top of hill above Sioux Falls	340.5	1404 ....
Sioux Falls	341.6	1375 ....
Big Sioux River, water	341.7	1355 ....

Iowa & Dakota Division, Chicago, Milwaukee & St. Paul Railway.

Copied from profiles in the office of George H. White, Engineer, Minneapolis.

	Distances in miles from N. McGregor.	Height in feet above the Sea.
Low and high water in Mississippi River at McGregor.	.....	615.9-634
North McGregor	0	633 ....
Monona	14.07	1221 ....
Luana	17.90	1132 ....
Postville	24.49	1207 ....
Castalia	30.64	1257 ....
Ossian	35.70	1281 ....
Calmar	42.04	1269 ....
Summit, grade	42.90	1300 ....
Conover	45.26	1247 ....
Cresco	60.80	1312 ....
Lime Springs	71.78	1258 ....
Chester	76.41	1244 ....
Le Roy	84.25	1298 ....
Decorah	53.90	900 ....
Turkey River, water	47.39	1002 ....
Fort Atkinson	47.73	1023 ....
New Hampton	69.06	1166 ....
Middle Wapsipinicon River, water	72.84	1061 ....
Chickasaw	76.66	1148 ....
Crossing C. V. R. R.	88.15	1020 ....
Charles City	88.53	1012 ....
Cedar River, water	89.65	995 ....
Shell Rock River, water	106.45	1033 ....
Shell Rock River, bridge	106.45	1053 ....
Lime Creek, water	112.55	1052 ....
Lime Creek, bridge	112.55	1071 ....
Mason City, depot and crossing, R. R.	115.90	1130 ....
Clear Lake, depot	125.67	1237 ....
Summit, grade	131.56	1272 ....
Garner	135.20	1227 ....
East Fork of Iowa River, water	137.91	1200 ....
Crossing, M. & St. L. Ry	146.19	1210 ....
Britt	147.19	1232 ....
Summit, grade	155.09	1269 ....
Wesley	156.87	1254 ....
Near Algona (0 of line west)	168.19	1191 ....

Iowa Division, Illinois Central Railroad.

From GANNETT'S List of Elevations, fourth edition.

	Heights in feet above the Sea.
Fairfield Junction	1131
Manchester	933
Winthrop	1080
Independence	924
Waterloo, Cedar River	864
Ackley	1141
Summit between Cedar and Iowa rivers	1221
Iowa Falls, Iowa River	1071
Alden	1165
Summit between Iowa River and its South Fork	1204
South Fork of Iowa River	1159
Blainsburg	1230
Summit between Iowa and Boone Rivers	1260
Webster City	1039
Duncomb	1111
Summit between Boone and Des Moines rivers	1171
Fort Dodge	1001
Summit between Des Moines and Raccoon rivers	1330
Raccoon River	1279
Summit between Raccoon and Little Sioux rivers	1519
Cherokee, Little Sioux River	1176
Summit between Little Sioux and Floyd rivers	1488
Floyd River	1166

Chicago & Northwestern Railway, in Iowa.

From GANNETT'S List of Elevations.

Marshalltown	905
State Center	1093
Nevada	1024
Ames	943
Boone	1162
Moingona, bridge over Des Moines River	914
Moingona, low water of Des Moines River	877
Ogden	1116
Beaver	1048
Grand Junction	1062
Jefferson	1078
Raccoon River	1004
Glidden	1238
Carroll	1247
Arcadia, on divide between the Mississippi and Missouri rivers	1446
Divide, natural ground	1468
Denison	1199
Council Bluffs	1007

Minneapolis & St. Louis Railway.

From ROBERT ANGST, Assistant Engineer, Minneapolis.

	Distance in miles from Minneapolis.	Height in feet above the Sea.
Minneapolis	0.	825 ....
Hopkins	8.7	919 ....

	Distances in miles from Minneapolis.	Height in feet above the sea.
Eden Prairie	15.2	882
Summit, grade	18.7	875
Chaska	22.7	725
Carver	24.7	719
Low water in Minnesota River	24.7	689
Merriam Junction, St. P. & S. City R. R.	27.2	753
Jordan	32.3	758
Helena	36.3	886
New Prague	42.6	973
Montgomery	50.0	1063
Mulford's Siding	54.6	1060
Kilkenny	58.6	1056
Waterville	65.4	1008
Iosco	69.7	1146
Waseca	76.2	1151
New Richland	88.7	1178
Hartland	94.9	1247
Manchester	100.9	1258
Albert Lea	108.0	1224
Twin Lakes	115.0	1255
Norman	121.4	1279
Lake Mills	127.2	1264
Benson's Grove	136.0	1216
Forest City	141.7	1220
Crossing C., M. & St. P. R'y	155.5	1207
Britt	156.3	1230
Corinth	167.0	1180
Livermore	181.6	1135
Humboldt	192.0	1089
Fort Dodge, upper depot	210.0	1120

St. Paul & Sioux City Division, Chicago, St. P., Minneapolis & Omaha R'y.

Copied from profiles in the office of T. P. GERE, Superintendent, and H. S. TREHERNE, Assistant Engineer, St. Paul.

a. MAIN LINE.

	Distance in miles from St. Paul.	Height in feet above the Sea.
Saint Paul	0.	698.4
Mendota	5.5	718
Nicols	9.9	706
Hamilton	17.7	714
Eagle Creek, bridge	19.7	708
Bloomington	21.2	738
Shakopee	26.8	741
Summit, grade	32.6	764
Brentwood	38.0	749
Summit, grade	40.0	763
Belle Plaine	45.6	725
High water in Minnesota River here	45.6	718
Blakeley	49.9	728
East Henderson	56.8	734
Le Sueur	61.5	758
High water in Minnesota River here	61.5	735
Ottawa	67.6	790
East Saint Peter	73.4	748
Kasota Junction	75.9	800

	Distances in miles from St. Paul.	Height in feet above the sea.
Summit, grade	77.8	837
Mankato	84.0	791
Blue Earth River, low and high water	86.2	756–774
Blue Earth River, bridge	86.2	795
South Bend	87.6	808
Minneopa bridge, 68 feet above water	89.2	863
Minneopa	89.4	871
Summit Grade	95.6	992
Lake Crystal	97.3	994
Summit, grade	102.2	1009
Iceland	104.1	998
Medalia	109.0	1021
Watonwan River, water	110.5	979
Lincoln	116.4	1042
Saint James	121.6	1073
Butterfield	130.1	1184
Mountain Lake	137.0	1300
Bingham Lake	143.2	1420
Summit, grade	144.1	1437
Windom	147.8	1353
Des Moines River, water	148.1	1331
Bluff Siding	149.7	1425
Wilder	154.0	1448
Heron Lake, water	159.0–159.5	1403
Heron Lake, depot	160.3	1417
Hersey (Brewster)	170.0	1485
Elk Creek, water	171.5	1473
Summit, grade	178.2	1588
Worthington	178.4	1582
East Okabena Lake, water	178.5	1569
Junction of Sioux Falls Branch	181.8	1633
Summit, grade	182.3	1654
Summit, grade	184.6	1656
Bigelow	187.8	1631
State line	188.3	1643
Summit, grade, 1647; surface	188.9	1653
Sibley	195.9	1509
St. Gilman	202.4	1442
Sheldon	212.1	1406
Hospers	220.1	1338
East Orange	228.5	1302
Seney	239.7	1221
Le Mars	244.2	1221
Floyd River, here	244.2	1197
Sioux City	270.0	1122

b. WOODSTOCK BRANCH.

Heron Lake, junction	160.3	1417
Dundee	168.4	1443
Avoca	180.1	1533
Two summits, grade	201.1–201.9	1850–1849
Murray and Pipestone county line, grade	202.5	1839
Woodstock	204.3	1822
Rock River, water	208.3	1645
Summit	211.5	1785
Pipestone City	215.4	1715
Big Sioux River at Flandreau	230.8	1501
Prairie, 4 miles further west	235.0	1662

c. SIOUX FALLS BRANCH.

	Distances in miles from St. Paul.	Height in feet above the sea.
Junction	181.8	1633
Summit, grade	184.5	1691
Little Rock River, water	187.4	1629
Little Rock River, bridge	187.4	1649
Rushmore	190.1	1665
Adrian	196.9	1538
Kanaranza Creek, water	198.0	1499
Kanaranza Creek, bridge	198.0	1511
Summit, grade	199.5	1569
Drake	203.7	1516
Elk Slough, grade	206.2	1469
Summit, grade	207.1	1515
Rock River, water	210.3	1423
Luverne	211.1	1451
Summit, grade	216.1	1543
Beaver Creek, depot	219.3	1443
Beaver Creek, water	219.8	1385
State line	224.4	1383
Valley Springs	225.2	1392
Big Sioux River, low and high water	232.4	1281-1302
Big Sioux River, bridge	232.4	1307
Terrace, south of river	234.4	1363
Sioux Falls	240.2	1394
Big Sioux River, low and high water	240.4	1381-1385
Summit, grade	241.6	1471
Big Sioux River, water	243.4	1403
Skunk Creek, water, Sec. 31, T. 102, R. 50	250.0	1449
Skunk Creek, bridge	250.0	1465
Hartford Siding, Sec. 22, T. 102, R. 51	254.4	1561
Summit, grade, Sec. 9, T. 102, R. 52	261.2	1692
East Vermilion River, water, Sec. 27, T. 103, R. 53	268.0	1455
East Vermilion River, bridge	268.0	1469
Montrose Siding, close west of last	268.3	1471
West branch of E. Vermilian River, water, at S. W. corner of Sec. 15, T. 103, R. 53	269.5	1468
Bridge here	269.5	1480
Summit, grade	275.9	1586
Salem, Sec. 13, T. 103, R. 55	279.5	1517
West Vermilion River, watar, Sec. 15, T. 103, R. 55	281.0	1457
Wolf Creek, water, Sec. 20, T. 104, R. 56	290.6	1370
Fawn Lake, water, T. 105, R. 58	303.5	1320
Stony Creek, water, Sec. 25, T. 106, R. 60	313.0	1253
James River, water, Sec. 12, T, 106, R. 61	320.2	1212
Prairie, 5 miles west of last	325.0	1276

d. FROM LUVERNE TO DOON.

Luverne	211.1	1451
Ash Creek depot	218.7	1396
State line	221.6	1374
Rock Rapids	226.5	1344
Rock River, low and high water	231.0	1296-1311
Doon	238.9	1282
Rock River at S. line of Lyon county, Iowa, low and high water	240.2	1248-1266

Elevation of the Terminal and Medial Moraines in Minnesota, Iowa, and Dakota.

a. FROM BECKER SOUTH TO FREEBORN COUNTY.

	Height in feet above the Sea.
At White Earth Agency	1600
East of Detroit	1450–1500
East of Lake Lida	1425
East of Fergus Falls	1300
Leaf hills	1400–1750
At Glenwood	1250–1300
Blue Mounds	1250–1300
In Meeker and Wright counties	1225–1000
In Hennepin and Scott counties	950–1050
In Le Sueur and Rice counties	1050–1150
In Waseca county	1100–1200
In Steele county	1150–1350
In Freeborn county, eastern Moraine	1275–1300
Western or inner Moraine in this county	1300–1375
Kiester hills, Faribault county	1300–1400
Medial Moraine, northwest to Delevan	1300–1100

b. IN IOWA.

In Worth and Winnebago counties	1250–1350
Pilot Mound, Hancock county, about	1425
Medial Moraine, northwest to Fairmont, Minn	1325–1225
Medial Moraine, west to Lake George	1250–1300
In Wright and Franklin counties	1350–1200
In Hardin and Hamilton counties	1250–1150
Mineral ridge, in northern Boone county, about	1200
In Guthrie and Carroll counties	1200–1325
In Sac and Buena Vista counties	1275–1500
In Palo Alto, Clay, Emmett and Dickinson counties	1300–1600
Spirit Lake, about 1400; hills west of do	1475–1525
In northeastern Osceola county	1550–1675

c. THE COTEAU DES PRAIRIES.

1. *The Eastern or Inner Moraine.*

In Jackson county	1450–1475
Blue Mounds, Cottonwood county	1450–1525
In Murray and Lyon counties	1500–1600
In Lincoln and Yellow Medicine counties, and onward in Dakota	1500–1650
Antelope Hills range	1250–1300

2. *The Western or Outer Moraine.*

In Nobles county	1650–1750
In Murray county	1750–1900
In northeastern Pipestone county	1850–1900
In southwestern Lincoln county	1900 1960
In Dakota, from the west line of Lincoln county to the head of the Coteau des Prairies	1900–2050

d. MEDIAL MORAINE.

	Height in feet above the sea.
Northward to Devil's Lake and Turtle Mountain, mostly	1400–1600
Devil's Lake (Nicollet)	1476 ....
Mini-wakan-chante, hill, south of do. (Nicollet)	1766 ....
Turtle Mountain (Dawson's map)	2150 ....
Turtle Mountain (U. S. By. Com. profile)	2000–2534

e. TERMINAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO THE COTEAU DU MISSOURI.

In Codington, Hamlin, Brookings and Lake counties	1800–1900

f. THE COTEAU DU MISSOURI.

Through central Dakota	1800–2200
At the north line of the United States	2000–2200

X.

CHEMISTRY.

ANALYSIS BY PROF. DODGE.

MINNEAPOLIS, Dec. 14, 1880.

PROF. WINCHELL—

Dear Sir:—I hand you, at length, results of analysis of the substance * you left with me at the chemical laboratory about two months since—the lime-clay material stated to have character of a cement.

Hoping tnat the results I communicate may not come too late to be of any service, I remain,

Very truly yours,
JAMES A. DODGE.

Mineral powdered, dried at 100°c., digested with dil. Hcl.:—

Dissolved by Hcl	55.1p.
Residue	46.9
	100.0

Analysis of portion dissolved by Hcl.:—

CO_2	41.06p	21.8p.	of entire	mineral.
SiO_2	0.98	0.52	"	"
Al_2O_3	traces	.....	"	"
Fe_2O_3	6.78	3.6	"	"
CaO.	49.53	26.3	"	"
MgO.	1.51	0.8	"	"
K_2O	traces	.....		
Na_2O	traces	.....		
	99.86p	53.02p		

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* This substance is a clay from the Red river valley, near Grand Forks, Dakota.

Analysis of portion undissolved by Hcl.: Boiled with solution of carb. of soda, gave only slight traces of $Si.O_2$. Fused with carb. soda-potass., gave:

$Si\,O_2$	61.69p	28.93p.	of entire	mineral
$Al_2\,O_3$	29.93	14.04	"	"
$Fe_2\,O_3$	5.99	1.91	"	"
$Ca\,O$	traces	.....	"	"
$Mg\,O$	0.98	0.46	"	"
$K_2\,O$	traces	.....		
$Na_2\,O$	traces	.....		
	98.59p	46.24p		

XI.

ORNITHOLOGY.

(REPORT OF DR. P. L. HATCH.)

PROF. N. H. WINCHELL—

Sir:—The present year has made no signal additions to the number of species of birds found to belong in the State. Explorations have been made over considerable sections hitherto unnoticed, and more critically over those somewhat familiar to me in the past, which have been rewarded by much desirable information, but without any discoveries of new forms, except in finding some accidental stragglers from well-known habitats, as in the case of the cinnamon teal, *Querquedula cyanoptera (Viriell), Cassin,* found at Bigstone lake, on the western border of the State. It is highly probable that very little remains to be done in the work of identification. There can be no doubt that occasionally a species will yet be added from those known to visit the same latitudes in contiguous territories, or even from more remote localities. Several such have recently been added to the lists of such old states as Maine, Massachusetts and Ohio. Indeed several that are new to science have recently been collected and described by competent and reliable ornothologists, resident in those states, which multiplies the probabilities that such will be the case here, yet this does not affect the conclusion that the list for Minnesota is about full. Entertaining this view, while employing the utmost vigilance to let none escape my notice, I have devoted my attention principally to the local habits, relative numbers and migrations of those already identified. I desire in this way to make the history of the birds of Minnesota, when completed, of the most value to the ends for which this subdivision of the State natural history survey was instituted. I find it no small undertaking to ascertain the average distribution of species on so wide a domain, considerable of which is remote and some of which is extremely difficult to explore after access has been attained.

I understand better than I did once, why so few competent naturalists have undertaken the life-histories of birds in the interest of agriculture. To follow a single species from the time of its arrival until its departure, and record its habits of migration, feeding through all the months, nesting, rearing and protecting its young, seems to be task enough for the spare hours of any one individual, but what of it when instead of one we have nearly three hundred. While, however, I am doing this with the assistance of all reliable aid which I can enlist, there is an increasing demand for a correct list north for the use of collectors and for scientific purposes in the other states and foreign countries, which I have now completed and herewith place in your hands for publication, if it shall meet your approval.

Yours very respectfully,
P. L. HATCH.

Minneapolis, October 21, 1880.

A LIST OF THE BIRDS OF MINNESOTA,

BY DR. P. L. HATCH, OF MINNEAPOLIS.

This list was in the hands of the printer long since, when a disastrous conflagration destroyed it, and it has been impossible to give its re-writing the measure of carefulness which the first manuscript received. If errors shall have crept in I believe they will be found to be unimportant. Although unfortunatety delayed by the circumstance mentioned, I have fulfilled my purpose and my promise to the many who have been calling on me for it so long and so complimentarily.

1. **Turdus migratorius**—ROBIN—common over the State.
2. **T. mustelinus**—WOOD THRUSH—common for the species.
3. **T. pallasii**—HERMIT THRUSH—proportionately represented.
4. **T. swainsoni**—SWAINSON'S THRUSH—common, and the variety Aliciæ said to have been obtained.
5. **T. fuscescens**—WILSON'S THRUSH—not as frequently seen, perhaps, as the last.
6. **Mimus carolinensis**—CATBIRD—exceedingly common.
7. **Harporhynchus rufus**—BROWNTHRESHER—very common.
8. **Sialia sialis**—BLUEBIRD—not less common than last.
9. **Sialia mexicana**—WESTERN BLUEBIRD—only one seen—Red River.
10. **Regulus calendulus**—RUBY-CROWNED KINGLET—common in migration associated with Satrapa.
11. **Regulus satrapa**—less frequently seen in migration.
12. **Polioptila coarulea**—BLUE-GRAY GNAT CATCHER—very rare.
13. **Lophophanes bicolor**—TUFTED TITMOUSE—exceedingly rare.
14. **Parus atricapillus**—BLACK-CAPPED TITMOUSE, or "Chickadee"—common and a permanent resident.
15. **Parus atricapillus, var. septentrionalis**—rare, but seen several times.
16. **Sitta carolinensis**—WHITE-BILLEDNUTHATCH—common resident.

17. **Sitta canadensis**—RED-BILLED NUTHATCH—less common resident.

18. **Oerthia familiaris**—BROWN CREEPER—common.

19. **Thryotorus bewickii**—BEWICK'S WREN—common in summer.

20. **Troglodites ædon**—HOUSE WREN—common.

20½. **T. ædon, var. parkmani**—HOUSE WREN—common

21. **Anorthura troglodytes, var. Hyemalis**—WINTER WREN—also common.

22. **Telmatodytes palustris**—LONG-BILLLD MARSH WREN—common

23. **Oistothorus stellaris**—SHORT-BILLED MARSH WREN—also common.

24. **Eremophila alpestris**—SHORELARK—very common.

25. **Anthus ludovicianus**—TITLARK—not uncommon in migration and sometimes abundant.

26. **Neocorys spraguei**—MISSOURI SKYLARK—very rare.

27. **Mniotilta varia**—BLACK AND WHITE CREEPER—Rather a common warbler—breeds here.

28. **Parula americana**—BLUE YELLOW BACKED WARBLER—not common.

29. **Helminthophaga pinus**—BLUE-WINGED YELLOW WARBLER—about like the last species in freauency.

30. **H. chrysoptera**—BLUE GOLDEN WINGED WARBLER—not abundant. Breeds here however.

31. **H, Ruficapilla**—NASHVILLE WARBLER—common and breeds here in many observed localities.

32. **H. celata**—ORANGE-CROWNED WARBLER—common, and breeds here also.

33. **H. peregrina**—Another warbler seen abundantly during migration—a few nests have been seen.

34. **Dendroeca aestiva**.-BLUE-EYED YELLOW WARBLER-the most common of the Warblers during summer, and breeds here in great abundance.

35. **D. virens**—BLACK-THROATED GREEN WARBLER—a much less numerous specie; breeds here.

36. **D. cœrulescens**—BLACK-THROATED BLUE WARBLER—often seen in migration—I am not aware of any nests having been taken, but think it breeds in the State.

37. **D. cœrulea**—CŒRULEAN WARBLER—Occasionally seen in spring—Little known of its local habits.

38. **D. coronata**—YELLOW-RUMPED WARBLER—The earliest and by far most numerous of all the warblers during migration, and breeds to some extent in the vicinity of Lake Superior.

39. **D. striata**—Black-Poll Warbler—Very common from the 10th to the 20th of May—Breeds here.

40. **D. castanea**—Bay-brested Warbler—Often observed in migration—Little more known of it.

41. **D. blackburniæ**—Blackburnian Warbler—Rather a common migrant and breeds here.

42. **D. pennsylvanica**—Chestnut-sided Warbler—Quite common—Nests have frequently been obtained.

43. **D. maculosa**—Black and Yellow Warbler—Not uncommon—I have seen no nests, but have no doubt as to its breeding here.

44. **D. tigrina**—Cape May Warbler—Very common in migration.

45. **D. palmarum**—Yellow Red-poll Warbler—Not very infrequent in a short period of its migration—No nests seen as yet.

46. **D. pinus**—Pine Creeping Warbler—Seen only in migration except in a single instance in Grants county by T. S. Roberts in the early part of June.

47. **Seiurus aurocapillus**—Golden-crowned Thrush—common during migration, and nests are occasionally observed.

48. **S. noveboracensis**—Water Thrush—not very common but also breeds here.

49. **Oporornis agilis**—Connecticut Warbler—rare.

50. **Geothlypis trichas**—Maryland Yellow-throat—very common—breeds here abundantly.

51. **G. philadelphia**—Mourning Warbler—seen rather infrequently—I think one nest has been obtained by Mr. T. S. Roberts. Mr. Trippe, quoted by Dr. Cones, found it very common and breeding here abundantty, but twenty-two years residence has afforded me less favorable results. I have not looked for it, however, in the localities he mentioned.

52. **Icteria viridis**—Yellow-breasted Chat—Very rare as yet—Only seen on the western borders of the State and in Dakota along the Missouri.

53. **Myiodioctes pusillus**—Green Black-capped Fly-catcher—Not very abundant but breeds here.

54. **M. canadensis**—About like the last species, and the nests are said to have been seen.

55. **Setophaga ruticilla**—Redstart—Common, and breeds here in well-observed localities.

56. **Pyranga rubra**—Scarlet Tanager—Every year becoming more common—Nests often taken.

57. **Hirundo Horreorum**—Barn Swallow—Abundant in some sections, but not universally so.

58. **Tachycineta bicolor**—White-bellied Swallow—Abundant.

59. **T. thalassina**—Violet-green Swallow—Not so well represented as the last.
60. **Petrochelidon lunifrous**—Eave Swallow—Common.
61. **Cotyle riparia**—Bank Swallow—Also very common.
62. **Stelgidopteryx serripennis**—Rough-winged Swallow—not common.
63. **Progne purpurea**—Purple Martin—abundant.
64. **Ampelis garrulus**—Bohemian Wax-wing—This winter visitants numbers vary so much from year to year as to forbid any approximately definite description—sometimes common.
65. **A. cedrorum**—Cedar Bird—common, and breeds in various section.
66. **Vireo olivaceus**—Red-eyed Vireo—common.
67. **V. philadelphicus**—Brotherly-love Bird—quite a number have been identified, but I do not think it a common specie.
68. **V. gilvus**—Warbling Vireo—delightfully common.
69. **V. flavifrons**—Yellow-throated Vireo—not at all common, but breeds here.
70. **V. solitarius**—Solitary Vireo—common in migration. Breeds in northern sections of the State.
71. **V. noveboracensis**—White-eyed Vireo—rare as far as yet observed—at least not common.
72. **V. bellii**—Bell's Vireo—not a common specie.
73. **Collurio borealis**—Great Northern Shrike—Is fairly common but far less so than the next species.
74. **C. excubitoroides**—White-rumped Shrike—Which is exceedingly common.
75. **Hesperiphona vespertina**—Evening Grosbeak-Like the Chatterer or Bohemian wax wing. The representation of these winter visitors is exceedingly variable, yet never as great as in that species.
76. **Pinicola enuncleator**—Pine Grosbeak—Much the same as the Evening Grosbeak.
77. **Carpodacus purpureus**—Purple Finch—Common occasionally in fall migration.
78. **Curvirostra americana**—Red Cross-bill—Not exactly common—Breeds in north part of the State.
79. **C. leucoptera**—White-winged Cross-bill—Rather rare.
80. **Aegiothus linarius**—Red-poll Linnet—Common in winter.
81. **Chrisomitris pinus**—Pine Linnet—Not rare.

82. **C. tristis**—AMERICAN GOLDFINCH—very common and breeds extensively.

83. **Plectrophanes nivalis**—SNOW BUNTING—a very abundant species in winter.

84. **P. lapponicus**—LAPLAND LONGSPUR—not as constant during the winter but very numerous in both migrations.

85. **P. ornatus**—CHESTNUT COLORED BUNTING—common along the Red River, where it breeds.

86. **P. pictus**—PAINTED LARK BUNTING—not much observed, but identified.

87. **Centronyx bairdii**—BAIRD'S SPARROW-common along the Red River where it breeds.

88. **Passerculus savanna**—SAVANNA SPARROW—common, breeding here abundantly.

89. **Poocætes gramineus**—BAY-WINGED BUNTING—common.

90. **Coturniculus passerinus**—YELLOW WINGED SPARROW—less common than the last.

91. **C. leconti**—LECONTE'S SPARROW—well identified.

92. **Melospiza lincolni**—LINCOLN'S SPARROW—about the same as Leconti—either or both are doubtless not infrequent in some localities.

93. **M. palustris**—SWAMP SPARROW—Abundant.

94. **M. melodia**—SONG SPARROW—Very common.

95. **Junco Tryemalis**—SNOW BIRD—Abundant—Breeds here.

96. **I. oregonus**—OREGON SNOWBIRD—A few stragglers.

97. **Spizella monticola**—TREE SPARROW—Common.

98. **S. socialis**—CHIPPING SPARROW—Very common.

99. **S. pusilla**—FIELD SPARROW—Also common.

100. **S. pallida**—CLAY COLORED SPARROW—Not rare, yet not what may be called common—It breeds along the Red river.

101. **Zonotrichia albicollis**—WHITE-THROATED SPARROW—Common—Breeds here, especially northward.

102. **Z. leucophrys**—WHITE-CROWNED SPARROW—Also breeds here, but is common along the Red river.

103. **Z. querula**—HARRIS' SPARROW—Not uncommon.

104. **Chondestes grammaca**—LARK FINCH—Common.

105. **Passer domesti (curse) cus**—ENGLISH SPARROW—More numerous than welcome.

106. **Passerella iliaca**—FOX-COLORED SPARROW—Not uncommon.

107. **Calmospiza bicolor**—Lark Bunting—Common in the northwestern part of the State.

108. **Euspiza americana**—Black-throated Bunting—Not a very constant or abundant species, but breeds here.

109. **Goniaphea ludoviciana**—Rose-breasted Grosbeak—A very common species.

110. **Cyanospiza cyanea**—Indigo Bird—Common for its species.

111. **Cardinalis virginianus**—Cardinal Red-bird—An ocasional straggler—Has been obtained in pairs under circumstances to justify the record.

112. **Pipilo erythrophthalmus**—Towhee Bunting—An average representation.

113. **Dolichonyx oryzivorus**--Bobolink—Common.

114. **Molothrus pecoris**—Cow-bird—Very abundant.

115. **Agelæus phœniceus**—Red-winged Blackbird—An abundant species.

116. **Xanthocephalus icterocephalus**—Yellow-headed Blackbird—Numerous in restricted localities.

117. **Sturnella magna.**—Meadow Lark—Common.

118. **S. Neglecta.**—Common along the Red River and occasional in other sections.

119. **Icterus spurius.**—Orchard Oriole—A rather common and constantly observed species.

120. **I. baltimore.**—Baltimore Oriole—Very common.

121. **Scholecophagus ferrugineus.**—Rusty Blackbird—Seen only in migration.

122. **S. cyanocephalus.**—Brewer's Blackbird—Breeds in considerable numbers on the Red River.

153. **Quiscalus purpureus.**—Crow Blackbird—Abundant.

124. **Corvus americanus.**—Crow—Not abundant, but is increasing in numbers.

125. **C. ossifragus.**—Fish Crow—Seen rarely in considerable flocks in migration.

126. **Pica melanoleuca, var hudsonica.**—Occasional.

127. **Cyanurus cristatus.**—Blue Jay—Very common.

128. **Perisoreus canadensis.**—Canada Jay—Met with frequently about Lake Superior.

129. **Tyrannus carolinensis.**—King Bird—Common.

130. **Myiarchus crinitus.**—Great-crested Flycatcher—not common, but breeds here.

131. **Sayornis fuscus**—Phœbe Bird—Common.

132. **Contopus borealis**—Olive-sided Flycatcher—Rather a common flycatcher—breeds here.

134. **C. virens**—Wood Pewee—Quite common.

134. **Empidonax acadicus**—Small Green-crested Flycatcher—Common in woodlands.

135. **E. traillii**—Trails' Flycatcher—Rare.

136. **E. minimus**—Least Flyctcaer—Not common.

137. **E. flaviventris**—Yellow-billed Flycatcher—Not abundant, but fairly represented.

138. **Chordeiles virginianus**—Nighthawk—Common.

139. **Antrostomus vociferus**—Whippoorwill—Common.

140. **Chœtura pelasgia**—Chimney Swift—Abundant.

141. **Trochilus colubris**—Ruby-throated Humming-bird—An average representation.

142. **Ceryle alcyon**—Kingfisher—Common.

143. **Coccyzus erythrophthalmus**—Black-billed Cuckoo—Common

144. **C. americana**—Yellow-billed Cuckoo—Not common.

145. **Hylatomus pileatus**—Pileated Woodpecker—Not an abundant but fairly represented species.

146. **Picus villosus**—Hairy Woodpecker—Common.

147. **P. pubescens**—Downy Woodpecker—Not quite as common as the last.

148. **Picoidie arcticus**—Black-backed-Three-toed Woodpecker—A rare winter species.

149. **Sphyrapicus varius.**—Yellow-bellied Woodpecker—Not very abundant.

150. **Melanerpes erythrocephalus.**—Red-headed Woodpecker—Very common in sections.

151. **Colaptes auratus.**—Golden-winged Woodpecker—Very common.

152. **Strix flamea var americana.**—Barn Owl.—In a former list I erroneously reported this owl as common.—It is a very rare species here although several have been obtained by collectors.—No nests as yet seen.

153. **Rubo virginianus.**—Great-horned Owl.—Common.

154. **Scops asio.**—Screech Owl—Not very common.

155. **Otus vulgaris var wilsonianus.**—Long-eared Owl.—Rather a common species.

156. **Brachyotus palustris.**—SHORT-EARED OWL.—Not rare.

157. **Syrnium cinereum**—GREAT GRAY OWL—This huge species is *not* very common in Minnesota.

158. **S. nebulosum**—BARRED OWL—generally found in summer when it is common.

159. **Nyctea nivea**—GREAT WHITE OWL—Seen frequently in winter.

160. **Surnia ulula var hudsonia**—HAWK OWL—Often collected in early spring.

161. **Nyctale telgmalmi var richardsoni**—RICHARDSON'S OWL—neither common nor very rare.

162. **N. acadica**—SAW-WHET OWL—Frequently seen in the forests.

163. **Circus cyaneus var hudsonius**—MARSH HAWK—The commonest of its eastern family.

164. **Nauclerus furcatus**—SWALLOW-TAILED HAWK OR KITE—Often seen in the densest forests.

165. **Accipiter fuscus.**—SHARP-SHINNED HAWK—Quite common, but less so than the next species.

166. **A. cooperii.**—COOPER'S HAWK—Breeds here extensively.

167. **Astur atricapillus.**—GOSHAWK— Not abundant, but fairly represented.

168. **Falco gyrfalco var labradora.**—GERFALCON—Rare.

169. **F. communis.**—DUCK HAWK,—Cannot be said to be very common, yet is often seen.—Breeds in the State.

170. **F. columbarius.**—PIGEON HAWK.—Rather rare.

171. **F. richardsonii.**—RICHARDSON'S FALCON,—Occasional.

172. **F. sparverius.**—SPARROW HAWK,—Very common,

173. **Buteo borealis.**—RED-TAILED HAWK,—Common.

174. **B. lineatus.**—RED-SHOULDERED HAWK,—Not so common as the Red-tailed Hawk.

175. **B. swainsonii.**—SWAINSON'S HAWK,—Not uncommon in the west part of the State.

176. **B. pennsylvanicus.**—BROAD-WINGED HAWK,—Rather a common buzzard.

177. **Archibuteo lagopus var sancti-johannes.**—Rare.

178. **Pandion halicetus.**—OSPREY OR FISH-HAWK.—A moderately represented species.

179. **Aquila chrysaetus.**—GOLDEN EAGLE.—Rare.

180. **Halicetus leucocepalus.**—BALD EAGLE—Common.

181. **Cathartes aura.**—TURKEY BUZZARD—Not common.

182. **Ectopistes migratorius.**—WILD PIGEON—Extremely variable—never quite abundant.

183. **Zenadura carolinensis.**—COMMON DOVE—Common.

184. **Meleagris gallopavo var. americana.**—Only found in the extreme southwestern part of the State and then very rarely.

185. **Tetrao canadensis.**—CANADA GROUSE—Northeastern part of the State.

186. **Pedicoecetes phasianellus.**—SHARPTAILED GROUSE—Common in northeastern and northern portions.

187. **Cupidonia cupido.**—PINNATED GROUSE—Commom.

188. **Bonasa umbellus.**—RUFFED GROUSE—Common.

189. **Lagopus albus.**—WILLOW PTARMIGAN—Rare.

190. **Ortyx virginianus.**—QUAIL—Becoming more common but not yet abundant.

191. **Squatarola helvitica.**—BLACK-BELLIED PLOVER—Rather common in both migrations.

192. **Charadrius fulvus var virginianus.**—GOLDEN PLOVER—Abundant in migration.

193. **Ægialitis vociferus.**—KILLDEER PLOVER—Common.

194. **A. semipalmata.**—RING PLOVER—Fairly common.

195. **Strepsilas interpres.**—TURNSTONE—Not common but well identified.

196. **Recuvirostra americana.**—AVOCET—Rare or not common.

197. **Himantopus nigricollis.**—STILT—Not very common, nor yet rare.

198. **Steganopus wilsonii.**—WILSON'S PHALAROPE—A moderately represented species.

199. **Lobipes hyperboreus.**—NORTHERN PHALAROPE—Not as frequently seen as the last.

200. **Phalaropus fulicarius.**—RED PHALAROPE—Rare.

201. **Philohela minor.**—WOODCOCK—Not abundant, yet frequently seen.

201. **Gallinago' wilsonii.**—WILSON'S SNIPE—Common.

202. **Macrorhampus griseus.**—RED-BREASTED SNIPE—Rare.

203. **Micropalma himantopus.**—STILT SANDPIPER—Occasionally seen.

204. **Ereunetes pusillus.**—SEMIPALMATED. SANDPIPER—About same as last.

205. **Tringa minutilla.**—LEAST SANDPIPER—Common.

206. **T. maculata.**—JACK SNIPE—Common.

207. **T. alpina.**—RED-BACKED SANDPIPER—Common.

208. **Caledris arenaria.**—Sanderling—Rare.

209. **Limosa fedoa.**—Great Marbled Gonert—Not rare, but not common except in the extreme northwest part of the State.

210. **Totanus semipalmata.**—Willet—Same as last.

211. **T. melanoleucus.**—Greater Telltale—Not rare.

212. **T. flavipes.**—Lesser Telltale—Common.

213. **T. solitarius.**—Solitary Sandpiper—Rather common.

214. **Tringoides macularius.**—Spotted Sandpiper—Common.

215. **Tryngites rufiscens.**—Buff-breasted Sandpiper—Rather rare.

216. **Numenius longirostris.**—Long-billed Curlew—Common along the Red river.

217. **N. hudsonicus.**—Hudsonian Curlew—Less common.

218. **N. borealis.**—Esquimaux Curlew—Not rare.

219. **Ardea herodius.**—Great Blue Heron—Common.

220. **A. egretta.**—White Heron—Occasional.

221. **A. candadissima.**—Snowy Heron—Very rarely seen.

222. **A. virescens.**—Green Heron—Common.

223. **Nyctiardea grisea, var. nævia.**—Night Heron—Not rare.

224. **Botaurus minor.**—Bittern—Very common.

225. **Aradetta exilis.**—Least Bittern—Common.

226. **Grus americana.**—White Crane—Not very common birds here.

227. **G. canadensis.**—Sandhill Crane—Common.

228. **Rallus elegans.**—King Rail—Occasional.

229. **R. virginianus.**—Virginia Rail—Common.

230. **Porzana carolina.**—Sora Rail—Very common.

231. **P. noveboracensis.**—Yellow Rail—Rather rare.

232. **Gallinula galeata.**—Florida Gallinule—Not common, but breeds in the Minnesota River bottoms.

233. **Fulica americana.**—Coot—Abundant throughout the state.

234. **Cygnus buccinator.**—Trumpeter Swan—Common in migration along the Red River where it breeds to some extent.

235. **C. americanus.**—White, or Whistling Swan—Common in some regions where it breeds.

236. **Anser albifrons var. gambelli.**—White fronted Goose—Probably stragglers but represented.

237. **A. hyperboreus.**—Snow Goose—abundant in the autumn migrations.

238. **A. coerulescens**—BLUE GOOSE.—Often seen in the Red River region in migration.

239. **Branta bernicla.**—BLACK BRANT—Not really common nor specially rare.

240. **B. canadadensis.**—COMMON WILD GOOSE—Abundant.

241. **B. hutchinsii.**—HUTCHIN'S GOOSE--Less common.

242. **Anas boschas.**—MALLARD—Abundant.

243. **A. obscura.**—BLACK DUCK—Rather common.

244. **Dafila acuta.**--PINTAIL DUCK—Common in its migrations.

245. **Chaulelasmus streperus.**—GADWALL DUCK--Common.

246. **Mareca americana** WIDGEON—Equally common.

247. **Querquedula carolinensis.**--GREEN-WINGED TEAL—Abundant in migrations and breeds in considerable portions of the State.

248. **Q. discors.**—BLUE-WINGED TEAL—Also abundant in migrations and breeds here.

249. **Q. cyanoptera.**—CINNAMON TEAL—Very rare straggler.

250. **Spatula clypeata.**—SHOVELLER DUCK—Breeds here, and is common.

251. **Aix spona.**—WOOD DUCK—Abundant breeder here.

252. **Fuligula marila.**—BLUE-BILL—An abounding species in both migrations and probably breeds here.

253. **F. affinis.**—LITTLE BLACK-HEAD—About as last.

254. **F. collaris.**—RING-NECKED DUCK—Not abundant except in occasional seasons.

255. **F. valisneria.**—CANVAS-BACK DUCK—Not usually very abundant, but breeds here.

256. **F. ferina, var. americana**—RED-HEAD DUCK—About like the last—not yet certainly known to breed here.

257. **Bucephala clangula.**—GOLDEN-EYE DUCK—Not uncommon in migration.

258. **B. albeola.**—BUTTER-BALL DUCK—Abundant, and is believed to breed in the northern section of the State.

259. **Harelda glacialis.**—Small flocks occasionally met in full migration.

260. **Œdemia americana.**—BLACK SCOTU—rare.

261. **Erismatura rubida.**—RUDDY DUCK—Not very common, but breeds here.

262. **Mergus merganser.**—SHELLDRAKE—Common, and breeds here.

263. **M. serrator.**—RED-BREASTED MERGANSER—Also common, and breeds here.

264. **M. cucullatus.**—HOODED MERGANSER—Like the last two, common, and breeds here.

265. **Pelicanus trachyrhynchus.**—White Pelican—Common, bre in colonies—in retired sections.

266. **Graculus carbo.**—Common Cormorant—rare.

267. **G. dilophus.**—Double-crested Cormorant—More common. b numerous.

268. **Larus argentatus.**—Herring Gull—Common in migration.

269. **L. delawarensis.**—Ring-billed Gull— Not uncommon.

269. **L. trydactylus.**—Kittiwake Gull—Not common.

270. **L. atricilla.**—Laughing Gull—Reported, but doubtful.

271. **L. franklini.**—Franklin's Gull—rare but identified.

272. **L. philadelphia.**—Bonaparte's Gull—More common.

273. **Sterna caspia.**—Caspian Tern—Several collected.

274. **L. forsteri.**—Forster's Tern—Common, and breeds here.

275. **S. superciliaris var, antillarum.**—Least Tern—Not rare. ably breeds here.

276. **Hydrochelidon lariformis.**—Black Tern—Very common breeds here extremely.

277. **Colymbus torquatus.**—Loon—Very common.

278. **C. septentrionalis.**—Red-Throated Diver—Rare.

279. **Podiceps coruntus.**—Horned Geebe—Common.

280. **P. griseigena var, hoebollii.**—Red-Necked Geebe—N mon. but breeds here.

281. **Podilymbus podiceps.**—Dabchick—Common.

THE WINTER BIRDS OF MINNESOTA.

BY THOMAS S. ROBERTS.

Prof. N. H. Winchell:

The question is often asked "How many kinds of birds are there in Minnesota in the winter time?" and supplemented not infrequently by the remark "not many, I suppose." There seems to be no more appropriate place for the answering of this question at length as it deserves than in the annual report of the survey. The present article is therefore respectfully submitted as an attempt to list our winter birds so far as they are known to the writer at the present time, with the introduction of such brief notes, mainly of a popular nature, in regard to the occurrence, habits or appearance of each species as may assist in its identification or be of interest otherwise.

The much greater abundance and attractiveness of birds in the summer season is very apt to entirely absorb the attention of the casual observer and to lead to the almost complete neglect of our winter birds; especially as the latter are greatly diminished in numbers, are comparatively silent and are largely shielded from observation by the many drawbacks to outdoor investigation in the winter time. But because the birds do not force themselves upon our attention in winter as they do in summer we ought not to conclude either that there are no birds present or that they are of little interest. The fact is that while birds are generally far from abundant in the cold season, particularly in respect to individuals, there are yet a goodly number of species to be found within the limits of the State. And among these every lover of birds cannot fail to find a number which are of much more than average interest. Birds which are attractive either in themselves on account of their beautiful or varied plumage, or by reason of curious and perhaps little known habits, or through having interesting personal histories recorded in the pages of our ornithologies.[*] The only opportunity to become acquainted with such birds as the handsome and little known evening grosbeak, its relative, the pine grosbeak, the elegant northern waxwing or the more common but little less interesting red-poll linnet, snow bunting and Lapland longspur, is during their sojourn here as visitors from their far northern summer homes. Moreover those birds that are present in the summer, have, in winter, to live and gain their livelihood under greatly changed conditions which presents them to the observer in new and generally very different aspects. The winter then offers a field for study peculiarly its own—not a rich and almost endlessly varied one like that of the summer and transition seasons, but yet a field amply repaying the outlay of time and effort necessary to become acquainted with its prominent features.

A word may be said here in reference to a noticeable trait of many winter birds which renders their observation all the easier if one is but looking for them. It is the preference often shown for the vicinity of dwellings, towns or even busy cities over the wild and unsettled country. The jays, grosbeaks, waxwings, sparrows and even hawks and owls are more likely to be found in the near vicinity of human habitations than elsewhere. The greater ease and certainty with which food and shelter can be obtained is no doubt the reason for this.

The probable number of birds constituting the avi-fauna of Minnesota is in the near neighborhood of three hundred. Of this number about two hundred and seventy-five species have thus far been collected or otherwise identified. About fifty species are known to occur in the State in the winter months. Of these a few are accidental; some are rare birds everywhere and at all times; while others are found only during occasional winters. There is scarcely the least probability that all would occur at any one locality: nor is it very probable that the whole number occur within the limits of the State during a single winter. An experience extending through several winters differing in character, together with a residence in different parts of the State, would therefore be necessary to form the winter acquaintance of all these birds.

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[*] Entertaining accounts of all the birds so briefly mentioned below may be found by reference to such works as Audubon's, Wilson's, and Nuttall's Ornithologies, Cone's Birds of the Northwest, Baird, Brewer and Ridgway's Birds of North America and numerous other minor works of a more popular nature, among which may be mentioned the writings of John Burroughs. The latter's "Wake Robin" is a little book full of charming bird biographies.

For the purpose of showing at a glance the manner of their occurence, our winter birds may be divided into groups somewhat as follows: *First*—Permanent residents, or those birds found in the State the year round; *Second*—Winter visitants, including such birds as come into the State from the north to pass the winter season; *Third*—What might be called, adopting a florist's term, "Half-hardy species," embracing those birds found regularly during mild winters or which appear during mild weather in the latter part of January and in February; and lastly, a few species that are purely accidental.

In the following lists, the species belonging to each of these groups are given in their natural order. It should be said, however, that in the case of two or three species the positions they hold are only provisional; as for example it is quite possible that both the hawk, owl and goshawk may breed in the northern part of the state, in which case they should be placed among the permanent residents instead of with the winter residents as below.

PERMANENT RESIDENTS.

1. **Parus atricapillus,** (*Linn.*) (BLACK-CAPPED CHICKADEE.)—A common, cheery little bird found almost everywhere, and known by sight and name to nearly every one who notices birds at all. They spend the winter in small companies which rove through the woods and thickets and not infrequently appear in the very centers of our cities and towns. The severest cold seems only to increase, if possible, their activity and bustle.

2. **Sitta caroliaensis,** (*Lath.*) WHITE-BELLIED NUTHATCH.)—A small, bluish, black-capped, white-bellied bird sometimes, though incorrectly, called "sapsucker." In common with the following species it spends its time creeping over the limbs and trunks of trees in search of food, wood-pecker-like, and so is often regarded as a small member of that family. It is not, however, related to the woodpeckers, and even its scansorial habits it will be found by a close observer to differ very much from those birds. The nuthatch is a common bird, of confiding and familiar habits and may be seen regularly about our streets and yards as well as in more retired localities. They are almost always in pairs and apparently remain constant throughout the year.

3. **Sitta canadensis.** *Linn.* RED-BELLIED NUTHATCH.—Smaller than the last and rusty colored beneath. Seldom found in winter in the southern part of the state where, however, it is frequent in fall and

spring. Mr. T. M. Tripple has recorded it as common in the central part of the state in December 1870.

4. **Loxia leucoptera.** *Gm.* WHITE-WINGED CROSSBILL.—Apparently much less common than the next, from which it may be distinguished by the presence of two white bars on the wing.

5. **Loxia curvirostra americana.** (*Wils.*) *Coues.* RED-CROSSBILL.—The crossbills are birds found almost exclusively in or near the coniferous forests of the State. as their food is largely obtained from the cones of evergreens. The name comes from the fact that the upper and lower mandibles are curiously crossed somewhat like the parts of a pair of scissors. It is this structure of the bill that enables the bird to remove the seeds from among the rough scales of the cones. The present species is common and a small flock of stragglers is sometimes seen in the neighborhood of Minneapolis and St. Paul. away from their usual habitat.

6. **Passer domesticus.** ENGLISH SPARROW.—This unwelcome alien appeared in Minnesota in the fall of 1876, having been previously introduced into St. Paul, I understand. It has not increased here in its usual extraordinary manner, owing in great part, doubtless, to our severe winters and late springs. At Minneapolis they have confined themselves, as yet. entirely to the business part of the city. where they build their large unsightly nests in all conceivable situations.

7. **Corvus corax.** *Linn.* RAVEN.—Common in the northern and central part of the State.

8. **Cyanurus cristatus.** (*Linn.*) *Sw.* BLUE JAY.—In the southeastern part of the State, a common bird familiar to every one. Of a bold and inquisitive disposition the Jay forages about our door yards and outbuildings, prying into every nook and corner. but never forgetting for an instant to be on his guard against any impending danger.

9. **Perisoreus canadensis.** *Bys.* CANADA JAY.—Abundant and well known in the pineries and more northern parts of the State under the various names of moose bird. whisky jack. carrion jay, meat bird, etc. It is even more bold and fearless than its blue-coated brother, and lives about 'the lumber camps and farm houses on the most intimate terms with all connected pith the culinary department. It is possessed of a ravenous appetite. and is quite omnivorous in taste. though scraps of meat of any kind are always preferable morsels. It seldem. if ever, appears in the southern part of the State.

10. **Hylotomus pileatus.** (*Linn.*) *Bp.* PILEATED WOODPECKER.—The largest of our woodpeckers, and with a single exception, the largest found in North America. It is nearly the size of a crow, mainly black and with a gorgeous scarlet cap and crest. "Logcock" is its common appellation. In heavy timber throughout the State it is a rather common bird and stragglers are likely to occur whenever the country is not actually prairie or brush land.

11. **Picus villosus.** *Linn.* HAIRY WOODPECKER.—Common. Colors. black and white. with red on the head in the male.

12. **Picus pubescens**. *Linn.* Downy Woodpecker.--Common. In marking almost exactly like the last, but only about one half the size. These two wookpeckers perform a service of incalculable value to man by the untiring warfare they wage upon the insects destructive to shrub and tree. All winter long they may be seen beside the walk, upon the lawn or in the more retired groves of the suburbs industriously at work upon the infected tree; and their very presence proves the existence of the insects or their eggs. The name Sapsuker is applied to these birds, but it is not deserved. They are naturally neither sap or bark eaters. The real culprit is the yellow-bellied woodpecker, *Sphyrapcius* (*various*), a bird that drills large holes entirely through the inner layer of bark and thus allows the sap to run out, often in considerable quantities. I have seen sugar maple trees tapped in this way and the whole lower part of the trunk of the tree saturated with the sap that oozed out. The bird is fond of the sap and may be frequently seen clinging to the hole of the tree and drinking the liquid that collects in the punctures. The yellow-bellied woodpecker is not a winter resident, but is common in the timber at other seasons of the year.

13. **Picoides arcticus** (*Sw.*) *Gray.* Arctic Woodpecker.—A rather common bird in some parts of the State, but only a straggler in the vicinity of Minneapolis. It displays a preference for old tamarack swamps in more or less heavily timbered country. It may be known by the uniform black of the upper parts, a square yellow patch on the crown in the male and the fact that it has but three instead of four toes. Its congener, the banded woodpecker (*Picoides Americanus*) is also a three-toed species but the back is banded with white. It has not yet been reported from Minnesota, though it probably occurs here rarely.

14. **Bubo virginianus** (*Gm.*) *Bp.*—Great-horned Owl.—The largest of our owls with "horns"—tufts of lengthened feathers on the head. Frequently met with in heavy timber.

15. **Scops asio** (*Linn*) *Bys.*—Screech Owl.—A small horned owl, about nine inches in length. Apparently not common-

16. **Nyctale acadica** (*Gm.*) *Bys.*—Acadian or Saw-whet Owl.—A diminutive bird only about seven and a half inches in length. Not common.

17. **Aquila chrysaetus**, *Linn.*—Golden Eagle.—A rare bird and but little is known of its occurrence here winter or summer. It is introduced here since it is known to occur in the summer and is usually resident where found.

18. **Haliaetus leucocephalus**. (*Linn*) *Sav.* White-headed or bald Eagle.—Occasionally occurs in the winter. An adult bird seen flying over Minneapolis, Jan. 1, 1879. (The two eagles may be distinguished in any plumage by noticing the feathering on the legs; in the golden eagle it extends to the base of the toes, while in the bald eagle the lower part of the tarsus or "shank" is bare.)

19. **Tetrao canadensis**. *Linn.* Canada or Spruce Grouse.--Found in the evergreen woods of the northern and central parts of the State.

where it is rather common. It is generally unfit for food, owing to the rank taste and odor imparted to the flesh by the leaves of spruce and other evergreens upon which it feeds.

20. **Pediœcetes phasianellus columbianus.** (*Ord.*) *Coues.* SHARP-TAILED GROUSE.—Common, except in the southeastern part ot the State. Not found about St. Paul and Minneapolis, except accidentally. It is an excellent food bird, the flesh being lighter in color than that of the prairie hen or pinnated grouse. It may be readily distinguished from the latter, not only by the marked difference in the pattern of coloration, but by the presence ot two lengthened feathers in the centre of the tail, from which character it takes its name. Great numbers of the sharp-tailed game are sold in our markets every season.

21. **Cupidonia cupido** (*Linn.*) *Bd.* PINNATED GROUSE.—Found throughout the State where not timbered, except, perhaps, a small area in the northwestern part. As winter approaches the pinnated grouse collect in vast flocks, called "packs", and during severe seasons many apparently retire to the corn fields and milder climate of Iowa.

22. **Bonasa umbellus** (*Linn*). *Steph.* RUFFED GROUSE.—Common, and well known by both the names pheasant and partridge, neither of which, however, belong properly to this bird. The ruffed grouse has greatly decreased in numbers in the more settled parts of the State during the last few years.

23. **Ortyx virginianus** (*Linn.*) *Bp.* QUAIL BOB-WHITE.—Rather common in the southern part of the State, but our severe winters and continuous snows prevent them becoming very numerous.

WINTER VISITANTS.

24. **Ampelis garrulus** *Linn.* NORTHERN WAXWING.—An irregular, though at times abundant visitor from the north. It usually appears in the northern part of the State from November 15, to December 15, and remains until the middle or latter part of April. (April 25, 1876; April 12, 1877; April 14, 1880.) * It sometimes appears in abundance in March and April, when it has not been seen during the previous winter, as in the spring of 1877.

They associate in flocks often of large size, and during their sojourn here live chiefly about our towns and cities, being quite tame and unsuspicious. Their beautiful crest and rich, smooth plumage gives them a jaunty, trim appearance, which has brought them into more general notice than perpaps any other one of our winter birds. The resemblance between the northern waxwing and the common cedar or cherry bird is so close, that many persons are only convinced that they are distinct after a close comparison of specimens. The present bird is larger and darker than its summer representative and has on the wing, in addition to the red wax-like appendages, common to both species, considerable white and often some yellow markings. The two species may sometimes be seen in early spring associating together in the same flock. The food of the northern birds while here consists of mountain ash berries, wild grapes, smilax berries, wolf-berries, high-bush cranberries, decayed fruit, especially apples, thrown out from stores or kitchens and such other palatable vegetable substances as they can find. But as spring opens, their food becomes largely insectivorous, and their habits accordingly undergo a marked change. They are no longer so familiar or such frequent visitors to back yards and alley ways; but are instead much more retiring and refined in habits. They capture the insects on the wing in the manner of flycatchers, and a whole flock may often be seen thus engaged for an hour or more at a time. Examination has shown that the insects just taken consist mainly of minute coleoptera, thousands of which must appear in the air with the disappearance of the snow.

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* When no locality is specified, dates refer to the vicinity of Minneapolis.

25. **Hesperiphona vespertina,** (*Coop.*) *Bp.* EVENING GROSBEAK.—A quite regular visitant but rather local in distribution and limited in numbers. It generally arrives in the southeastern part of the State in the early part of December, but sometimes much earlier, as in the fall of 1880, when the writer saw a flock of five in Isanti Co., on Oct. 28. It is one of the last of the winter birds to retire, remaining usually until the second or third week in May. (May 17, 1876, May 16, 1877, May 18, 1879.)

The male evening grosbeak is a beautiful bird being arrayed in a plumage of black, white, yellow and a peculiar "dusky olive," the colors handsomely contrasted or evenly shaded the one into the other. The female is much plainer, but the species may always be recognized by the short but very large conical bill, which is generally greenish horn color.

Like the waxwings the grosbeaks appear to court rather than shun the society of man. They are very tame and will spend an entire season about a city, having their headquarters at some central grove and frequenting the busiest thoroughfares to feed with entire unconcern upon the box-elders planted by the walk as shade trees. It is from the keys of the box elder and sugar maple that they derive their chief sustenance, and it is surprising to see the adroitness with which they remove the tiny kernel from its dry husk with their clumsy looking bill. Their principal utterance is a clear piping note delivered with much energy by male and female alike. They have also a weaker, screaming note which usually serves as an accompaniment or undertone to the general choral performance which is their most common way of expressing themselves when settled in some quiet spot. As a friend remarked upon listening for the first time to one of their united efforts, the general effect is very much like that produced by a lot of frogs piping in a woodland marsh on a still summer evening. There is an unread chapter in the history of the present bird, which, together with the fact that it is nowhere very common, causes it to be of more than usual interest to the ornithologist. Its nest and to a great extent its summer home and habits are as yet unknown.

26. **Pinicola enucleator** (*Linn*) *Cab.*—PINE GROSBEAK—A bird a little less in size than the robin; slate colored, with brassy yellow or reddish

on the head and rump in the female and immature birds, but the adult male carmine red nearly throughout when in full plumage. It is of irregular occurrence, being quite numerous some winters and then almost entirely absent for several winters together. During the winter of 1874–5 they were common in flocks about Minneapolis and were quite well represented during the winter just passed (1880–1). They appear in the latter part of November or early in December and leave in March (Mar. 13, 1875; Mar. 7, 1879). They have a mellow, sweet whistle, aud while here, a low, subdued song. Their food consists largely of sumach berries, mountain ash berries, high-bush cranberries, etc., but it is the seeds not the pulp of the berries of which they are fond. They reject entirely the pulp of the high-bush cranberry, simply pressing out and eating the single broad, flat seed.

27. **Ægiothus linaria** (*Linn*) *Cab.* RED-POLL LINNET—A sprightly little bird with a black chin patch and a dark crimson on the top of the head with sometimes a rare red plush over the entire heart. It is very abundant some seasons, appearing in large flocks and frequenting weedy fields and tamarack swamps. They appear about the first of November aud remain until the middle of April (April 18, 1875).

28. **Plectrophanes nivalis,** (*Linn.*) *Meyer.* SNOW BUNTING.—Common. Generally most numerous in late fall and early spring. Arrives in the latter part of October (one taken Oct. 16, 1875) and generally leaves in April, though stragglers are sometimes found in May (a pair, male and female, apparently mated, taken at Minneapolis May 14, 1875, and one seen May 5, 1876). A bird a little less in size than a bluebird, plumage much variegated with black, white and and reddish brown in the fall and winter but becoming mainly black and white in sharply defined areas in spring. Breeds within the Arctic Circle.

29. **Plectrophanes lapponicus,** (*Linn.*) *Selby.* LAPLAND LONGSPUR.—Similar to the last but much darker in color. The hind claw is very long, from which comes the name. The snow bunting and Lapland longspur are highly gregarious birds and during the fall, early spring and mild winters they often occur in countless thousands, frequenting prairies and fields where they feed upon the ends of grasses and weeds. The longspur appears in Hennepin Co. as early as September (taken Sept. 29, 1875; seen Sept. 30, 1880) and leaves in late April, though like the snow bunting it is occasionally found in May (three taken May 3, 1875, and a flock seen May 11, 1877).

30. **Spizella monticola,** (*Gm.*) *Bd.* TREE SPARROW.—A small, brownish bird with a dark spot on the breast and an unbroken rufus crown patch. An abundant migrant spring and fall, and some of the hardier birds remain here in sheltered places through the winter, though they are most noticeable mild seasons.

31. **Surnium cinereum,** (*Gm.*) *Aud.* GREAT GRAY OWL.—An immense, hornless owl occasionally taken in the state, but far from common.

32. **Nyctea scandiaca,** (*Linn.*) *Newt.* GREAT WHITE OR SNOWY OWL.—A well-known and wary bird which, while not exactly common, is yet generally and regularly distributed in open country. Taken at

Minneapolis Oct. 15, 1876, and stays sometimes in the southern part of the state until the second week in May.

33. **Surnia ulula hudsonia,** (*Gm.*) *Coues.* Hawk Owl.—A medium-sized owl of diurnal habits. So far as noticed it is uncommon in the southern part of the state, though it may be more numerous and breed in the northern, timbered part. Taken at Minneapolis Oct. 31, 1876, and again Dec. 1, 1876.

34. **Astur atricapillus,** (*Wils.*) *Jard.* Goshawk.—The hawk generally seen in winter. A bold and powerful bird that preys largely upon grouse and hares. Seen at Minneapolis Oct. 9, 1876, and young of year taken in Lake Co., Aug. 26, 1879.

35. **Bucephala islandica,** (*Gm.*) *Bd.* Barrow's Golden-Eye.—A beautiful black and white duck likely to occur wherever there is suitable open water. Several years ago, before the noise and activity became so great about the Falls of St. Anthony, a flock of these ducks used to spend the winter in the pool below the cataract. There is in the University Museum a female specimen of *B. islandica* taken at Minneapolis Jan. 13, 1877. Heretofore the *Bucephala* occurring in winter has been regarded as *clangula*, and while it is highly probable that that species does occur during the winter months, the only winter specimens that I have examined thus far is referable to *islandica*.

36. **Harelda glacielda** (*Linn.*) *Leach.*—Long-tailed Duck—Occurs on Lake Superior. I have in my collection two specimens kindly sent to me by Mr. Thos. W. Mayhew, of Grand Marais, Cook Co. They were taken at that place, one April 12, 1880, and the other about March 1, 1881. In answer to an inquiry in regard to the occurrence of the species, Mr. Mayhew replied : "They are not considered rare here in winter. They make their appearance about October nearly every fall, and will remain all winter if the Lake is open ; where they go when the Lake freezes I cannot say. I think they generally leave here about May. The Indians call them 'jack owly.'"

37. **Œdemia fusca,** *Swain.* Velvet Scoter Coot.—On two occasions I have seen ducks, evidently this species, in the river at Fort Snelling, once in January and once in April.

"HALF-HARDY."

All the species (except *Lanius borealis?*) here included under this head breed in the State, and when the winters are mild occur throughout the the year.

38. **Certhia familiaris.** *Linn*—Brown Creeper.—A very small, inconspicuous bird that is quite generally overlooked. May be known by its small size, dull markings, and habit of creeping up the trunks and limbs of trees. In its search for food it always begins at the base of the tree and passes spirally upward, probing every small hole and crevice with its fine, curved bill. Although sometimes found when the weather is quite severe, it is never numerous in the winter. (Dec. 10, 1874 ; Jan. 19, 1877 ; Feb. 23, 1878.)

39. **Eremophila alpestris** (*Forst.*) *Boie.*—HORNED LARK.—A bird of the prairie and open country, recognizable by the black and yellowish-white markings on the head, and black crescent on the breast, together with its quiet and unsuspicious nature. It frequents roads along which it collects a large part of its food. When the season is favorable, the sometimes larks appear in January, and by the last of February, have become numerous and are even paired and attending to nesting duties, as in the mild February of 1878. They can endure severe cold, and their absence in early winter, or sometime the entire season, is due mainly, in seems to me, to a scarcity of suitable food while the snows are so frequent and continuous. As soon as the ground becomes bare and slightly mellow in patches, however small, they return and then have the coldest weather that comes.

40. **Lanius borealis** (*Vieill*).—GREAT NORTHERN SHRIKE OR BUTCHER BIRD.—A bird about the size and general appearance of a mocking-bird, except that it is stronger built and has a powerful hooked and toothed bill. More commonly seen in spring and fall, but occasionally occurs during winter.

41. **Carpodacus purpureus** (*Gm.*) *Gray.*—PURPLE FINCH.—Present at Minneapolis during the mild winter of 1877-8 and occurring rarely colder seasons (Feb. 20, 1876). Male purplish red, except wings and tail; female and young dull-colored streaked; about six inches in length.

42. **Chrysomitris pinus** (*Wils.*) *Bp.*—PINE LINNET.—A small dull colored bird with concealed sulphur yellow markings on the wings and tail. Sometimes common in December and occurring occasionally throughout the winter. (Dec 25, 1877, Feb. 2, 1878.)

43. **Chrysomitris tristris.** (*Linn.*) *Bp.*—THISTLE BIRD GOLDFINCH.—In winter a brownish bird with black wings and tail, but becoming bright yellow in spring. It has a querulous note, oft repeated, and toward spring a varied, pleasing song. It sometimes occurs during rather cold winters and is generally common until the middle of December. (Dec. 11, 1875, Jan. 4, 1877, Feb. 10, 1877.)

44. **Juncus hyemalis.** (*Linn.*) *Sol.* SNOW BIRD.—Dark slate-colored, sharply contrasted on the breast with the bright white of the under parts. Seldom seen during winter. (Feb. 10, 1876, Jan. 21, 1880.)

45. **Corvus americanus,** *Aud.* CROW.—Sometimes appears in considerable numbers in February.

46. **Buteo borealis,** (*Gm.*) *Vieill.* RED-TAILED HAWK, HEN HAWK.—Uncommon in winter, but after a week of mild weather in January or February it may sometimes be seen sailing about high up in the air.

ACCIDENTAL.

47. **Turdus migratorius,** *Linn.* ROBIN.—Have heard of one hardy-dispositioned bird that successfully passed the winter of 1877—8 about the farm of Mr. J. D. Grimes, near Minneapolis. The season, however, was unusually mild.

48. **Anothura troglodytes hyemalis.** (*Vieill.*) *Coues.* WINTER WREN.—I am not quite positive about this species as a winter bird, but think that I have somewhere a record of its occurrence in February, which I cannot now find.

49. **Quiscalus purpureus æneus.** *Ridg.*—CROW BLACKBIRD. Occasionally appears in the midst of cold winters, seeming much more at home than would be expected. (Flock of four, Jan. 13, 1876.)

50. **Pica melanoleuca hudsonica.** (*Sab*). *Coues.* MAGPIE.—A single bird of this species was seen by Mr. Nathan Butler of Minneapolis, in the southaestern part of Stearns county, about 1858. Other than this, I have been able to learn nothing definite in regard to its occurrence, although it is a bird not easily mistaken or overlooked; being fifteen to twenty inches in length, mainly black with white markings on sides below, and with an exceedingly long tail, the feathers of which differ much in length.

51. **Gallinago wilsoni.** (*Temm.*) *Bp.*—WILSON'S SNIPE. JACK SNIPE. —Individuals sometimes remain about spring, runs until the middle of December or even into January the coldest winters. (Dec. 15, 1875, Dec. 15, 1877, Jan. 17, 1879).

52. **Anas boschas.** *Linn.* MALLARD DUCK. I have been informed that this duck often remains in spring lakes along the Minnesota River, and I have myself seen it as late as Nov. 28, (1875) after a month of severe weather.

In addition to the fifty-two species of birds mentioned above, there are several others which it is more than probable are found in Minnesota in winter, but as the writer has no knowledge of their actual occurrence here, they are not included in the present list. Among these are the following three of which have already been attributed to the state:- banded three-toed woodpecker, Tengmalius owl, red-shouldered hawk, ptarmigan and two or three waterfowl that probably occur on Lake Superior. But even though this list be not entirely complete, it may serve, perhaps, to convey some idea of the nature of our winter avi-fauna or to fix the proper names of a few of the birds around us.

THOS. S. ROBERTS.

Minneapolis, Minn., March, 1881.

APPENDIX A.

DETERMINATION OF LATITUDE AND LONTITUDE IN MINNESOTA.

OFFICE OF U. S. LAKE SURVEY
DETROIT, MICH., Dec. 3, 1880.

Prof. N. H. Winchell, State Geologist, Minneapolis, Minn.:

SIR:—Your letter of the 26th ultimo requesting latitudes and longtitudes of points in Minnesota has been received. Absence has delayed an earlier reply.

In the following list the longitudes depend on that adopted for the Lake Survey Observatory at Detroit, as 83°-03'—03'60. The latitudes were determined directly by observations made with Zenith telescope, except the cupola of the University where both the latitude and longitude depend upon observations made at St. Paul.

	LATITUDE.	LONGTITUDE W. OF GREENWICH.
Primary triangulation station North Base, on Minn. Point near Duluth	46°-45'—28.32	92°-04'—33.00
Easterly corner Custom House, St. Paul	44°-56'—42.96	93°-05'—34.03
Cupola University of Minn., Minneapolis	44°-58'—39.28	93°-14'—10.53
Astronomical Post, Court House Yard, Red Wing	44°-33'—44.16	92°-31'—59.25
Spire Catholic church, Red Wing	44°-33'—44.64	92°-31'—49.66

Very respectfully yours,

C. B. COMSTOCK,

Major of Engineers, and Brig. Gen. U. S. A.

APPENDIX B.

THE CUPRIFEROUS SERIES IN MINNESOTA.

BY N. H. WINCHELL.

[*From the Proceedings of the American Association for the Advancement of Science for* 1880].

The red shales and sandstones interstratified with the igneous rocks of the cupriferous series along the shore of Lake Superior in Minnesota, show various stages and kinds of metamorphism. While in some places, as at Good Harbor bay, they are not much changed by contact with the igneous layers separating them, in other places, they show a broken stratification, and a tough and siliceous texture, as at Tischer's, near Duluth, where these beds are finely and angularly jointed, have a red color and sometimes a jaspery or conchoidal fracture. In other places they take on a dull brown color, passing to a greenish-brown, becoming slaty and firm, or when in close proximity to igneous dikes, becoming black, dense and basaltiform, as at points east of Grand Marais. In the segregation of minerals, the first to appear are calcite and laumontite. These are disseminated with varying abundance through the shaly layers, as well as through the aluminous and red conglomerates, as seen at the mouth of the Manitou river and at numerous other places. They gather in seams, or in certain parts of the mass, or in the form of amygdules throughout the thickness of the exposed layers. This formation of laumontitic amygdaloids is particularly noticeable in those layers whose thickness is from a foot or two to twenty-five or thirty feet, and sometimes several may be seen alternating in the same bluff, or in a few rods along the shore, with beds of undoubted doleritic rock, as on the west coast of Agate bay, where may be seen five layers of igneous rock with four alternating layers of crumbling, thin-bedded laumontitic amygdaloid, styled "volcanic grits" by Norwood.

These amygdaloids are very susceptible to the destroying action of the waves and of the atmosphere, and their disintegration is the immediate cause of many of the purgatories and isolated arched beds of traprock that ornament the north shore of lake Superior.

When the source and supply of the heat were more continuous, involving greater thicknesses of the sedimentary beds, the siliceous material was more thoroughly fused and disseminated among the other elements. The more limited supply of air and water at these greater depths, seems to have produced, at least is coincident with, a greater abundance of felspathic material, instead of calcite and the hydrous zeolites, throughout the sedimentary layers. Thus the whole is sometimes changed to a non-differentiated ferruginous felsite. When the process was carried a little farther, crystals of red orthoclase appear in the mass, or of orthoclase in the form of translucent adularia, as in the rock of the "great palisades." When the metamorphism is carried still farther, involving in its slower progress large thicknesses of the red sedimentary shales and sandstones, thep become almost wholly crystalline, as seen in the red bluff that incloses Beaver bay on the west, and in the red granite bluff a few miles east of Beaver bay. The relationships of these changes with one another, and to the igneous rock, are evident at numerous places along the shore between Duluth and Grand Portage, and on Isle Royale; and their significance and application to the stratigraphic geology of the northeastern part of the state are very important. On passing inland from the lake shore back of Grand Marais, and up the Devil's Track and Brulé rivers, the red semi-metamorphic slates of the shore can be followed over a wide extent of territory, gradually becoming more changed and crystalline, in receding from the lake shore. They pass into red granite and gneiss (hornblendic) which rises in conspicuous hills, and shows perpendicular exposures along the lakes and streams, sometimes several hundred feet high, as at Brulé mountain, and at Misquah lake (T. 64.1 W., Sec. 22). In some places this highly crystalline condition of this red formation is seen to give place suddenly to areas of igneous rock of a dark color, and showing a very different mineral composition, and then to return again. This takes place sometimes on the high hills, the two kinds of rock alternating superficially in irregular patches, as at Duluth, and at Duck lake and Frog Rock river on the portage trail from Little Saganaga lake to the head waters of the Temperance river, in the northeastern corner of the state. Sometimes the tilted red sedimentary beds seem to be overlain by the igneous rock and sometimes underlain bv it, the red rock, when consisting of sandstone at first, having been hardened into a quartzite. Several tilted red quartzite hills, very similar to the quartzite hills at New Ulm and in Cottonwood and Rock counties, occur in this connection at Duck and Wind lakes, their relation to the igneous rocks being most perfectly exemplified. Sometimes this red quartzite becomes micaceous and also felsitic, as may be seen at Wind lake. The great extent and the more intense metamorphism of this red formation, in the country lying to the north and west of Lake Superior, accompanied by larger belts of the igneous rock, more coarsely crystalline, not only shows that the seat and source of the igneous action was there instead of in the basin of the lake, but also that it was longer continued. It implies also, that a similar modification of these beds may be looked for throughout the northwest, wherever the formation is known to have been upheaved by igneous forces, although the igneous rock itself may be wanting.

Northwest of Lake Superior the igneous rock forms the main watersheds, rising in two main ridges, or ranges of mountains that run southwestwardly, one known as the *Mesabi*, and one as the *Sawteeth mountains*, though the former name is not restricted to this belt of high land. The width of the belt of metamorphic red shales and sandrock, associated with the igneous rock, is about thirty miles in a right line, extending from the head waters of the Brulé and Temperance rivers to the shore of Lake Superior. The Sawteeth range of mountains, which is that nearer the Lake Superior shore, dies away in passing to the southwest, and the Mesabi belt of igneous outflow approaches the lake shore, appearing at Duluth in the form of the "Rice Point Granite." The tilted red shales, conglomerates and sandstones at Fond du Lac, a few miles west of Duluth, are the same as those seen associated with the igneous rock all along the shore. They lie there on a white-quartz, pebbly conglomerate, of a few feet in thickness, which lies unconformably on the roofing slates of the Huronian, the same formation that succeeds to the red rock formation toward the northwest, at Ogishke Muncie and Knife lakes, northwest of Grand Marais.

The mineralogical characters of these belts of igneous rock, which form some of the main features of the topography, seem to ally them to the Norian rocks of T. S. Hunt, and to the Labradorite rocks of Canada. At least if they be not the western extension of those formations, then those formations have not yet been discovered in Minnesota. But several traverses have been made of the country northwest of Lake Superior, for the purpose of geological examinations without finding anything that is at all comparable to those formations if it be not the rock of these hill ranges. The rock consists generally of some feldspar, which at Duluth has been found to be labradorite in large per cent., and at some places constituting over ninety per cent. of the mass, with varying proportions of augite or magnetite, or magnetic menaccanite, with various accessory ingredients, or minerals that result from change. It is massive, firm, dark-colored, and rises in low mountain ranges, as already stated. If its relation to the red granites and gneisses with which it is accompanied were not so evident, by simply noting the changes from the lake shore northwestwardly, it would hardly be presumed to be a parallel of the igneous rocks of the coast, any more than the red gneisses and quartzites would be of the shales and sandstones that are interbedded with them at the coast. So far as yet examined, these Labradorite rocks contain no bands of limestone, which is due probably to the fact that the Cupriferous Series in the northwest is not known to contain any beds of limestone. In the absence of this element, and in this only, so far as can be judged by the writer, these Labradorite rocks seem to differ from the Labradorite rocks of the "Upper Laurentian" of Canada.

Inferentially, therefore, the so-called "Upper Laurentian" containing *Eozoon Canadense*, seems to parallelize with the igneous rocks of the Cupriferous Series, or rather with the modified interbedded sedimentary portions of it, and hence the *Eozoon*, instead of being truly a Laurentian organism, seems to be one of the Cambrian or Lower Silurian. The abundant graphite of the "Laurentian" which pointed the way to the prediction of organisms in that formation, is also found in the modified quartzites and shales of the Cupriferous Series in perhaps equal abundance in the State of Minnesota.

APPENDIX C.

AN ANCIENT OUTLET OF LAKE MANITOBA.

ST. PAUL, MINN., May, 25th, 1881

Professor Winchell, Minnesota State Geologist, Minneapolis, Minn.:

SIR:—The following items relating to a supposed outlet of Lake Manitoba into the Assiniboine river, and other data, I have gathered from old journals (1874) and note books. The information is not as complete as I would like, but whatever you find herein I can vouch for. All the elevations given in this communication are referred to a datum plane 100 feet below the bench mark on Higgin's store on Main street, Winnipeg, Manitoba, and which is thirty-four (34) feet above the level of Lake Superior. The lots mentioned as being on the banks of the Assiniboine River are those of the Canadian government surveys of half-breed claims, as shown on the maps of the Dominion land office in Manitoba.

In the Parish of Baie St. Paul's and a short distance west of the big bend in the Assiniboine River known as the Bay, a narrow strip of water about six miles long and in no place over a mile wide forms what I take to be the end of a former outlet of Lake Manitoba. It is known as Long Lake, and varies in depth from six inches to six feet. The south end is about a quarter of a mile from the river. It runs northerly about two and a half miles and then turns abruptly and runs a little north of west for about three and a half miles. At the west end of Long Lake a creek (Long Lake Creek) falls into the lake. Going up the creek we run nearly due west for about one and a half miles, then the creek takes a southerly bend for about two miles, then westerly about four miles. This is the course of the creek proper; from its head there is a depression with a north-westerly trend gradually rising, having several branch depressions running northerly and north-easterly, and southerly and south-westerly. The summit of this main depression is from two to four feet lower than any other point of the water-shed between Lake Manitoba and the Assiniboine River, with an approximate elevation of 150 feet above datum. The depression beyond the summit, and having the same trend, becomes more and more defined as we go on, until it forms a cooley, or dry run, which leads into a small branch of the creek east of Portage creek, which, for the sake of distinction, I have called Dufferin creek and which falls into Lake Manitoba with a very slight current. The banks of this creek are low and shelving, having a slope of about 4 to 1. From the cooley before mentioned there are several branch cooleys, possibly connecting with branches of Portage creek. To explain why I am led to believe Long Lake to be the remains of an ancient water course, I will give the actual levels taken, referred to the datum line mentioned previously.

	Feet.
Elevation of Lake Manitoba and marsh surrounding south end	148.90
" " bottom of Dufferin creek at a point about one and a half miles south of township line.	148.38
" " top of bank of Dufferin creek at same point	164.84
Dufferin creek is here about nine inches deep.	
" " lowest point of ridge. (approximately)	150.00
Elevation of Long Lake	136.85
" " Land. 15 chains from Long Lake, southeasterly	139.44
" " " 25 " " "	140.04
" " top of bank of Assinibonie river at centre of lot 142......	146.28
" " Assiniboine river at centre of lot 142....................	134.13

The immediate banks of Long Lake Creek are from six to ten feet high, sloping 1½ to 1. The ground on the north slopes gradually upward to a gravel ridge for the first two miles. This ridge is probably six to eight feet above the immediate bank of the creek. The ground to the south also slopes gently upward, commencing to slope however some distance from the creek. The immediate banks of Long Lake are from six to ten feet high, sloping up gradually. At the south end of Long Lake there is a channel running westward for three miles, and then losing itself in the prairies. There is also a slight depression running southeasterly towards the river. The only objection that can be raised regarding this being an ancient outlet of Lake Manitoba, is that the immediate banks of the Assiniboine river are about nine feet above the present level of the water in Long Lake, but the ridges forming the channel of the supposed old watercourse are, I am strongly inclined to believe, in no place lower than fifteen feet above the level of Long Lake.

The following extracts may be found useful:

October 1, 1874. Elevation of B. M. on wall of second store below the Davis house, (Higgins' store) in Main street, Winnipeg—100 feet above datum elevation of B. M. on southeast corner of plinth of Fairbanks' weighing machine, about 100 yards south of Hudson Bay Company's store at Winnipeg is..	95.59
Elevation of top of bank of Red and Assiniboine at junction............	95.36
" " ordinary summer level of Assiniboine river.............	68.40
" " present level of Assiniboine river	65.79

NOTE.—The last two elevations were taken at the junction of the Assiniboine river with the Red river of the north.

Elevation of level of river Assiniboine at mouth of Colony creek.........	65.83
October 2, 1874. Elevation of river Assiniboine at road-crossing between lots 71 and 72, in parish of St. James..............................	68.18
Elevation of river Assiniboine (ordinary summer level) at same point as above...	68.97

Elevation of river Assiniboine (ordinary spring level) at same point as above 77.05

Elevation of river Assiniboine (ordinary spring flood) at same point as above 82.61

The summer, spring and flood levels are very rough, being pointed out by a settler and may not be relied on to one foot. Banks high and abrupt, composed of sand and clay in mechanical combination. Near the west end of lot 41 in the parish of St. James, a great number of boulders, from two to three feet in diameter of a decided granite nature appear on the north side of the river. Banks are twenty feet high, very abrupt, composed of clay and sand, mixed. An exposure of the bank of the Assiniboine river on the south side, near lot 53 in St. James' parish, shows five feet of loam and eight feet of sand. The sand evidently extends far below this. The stones in the river are principally lime and conglomerates, (with scattered basalt boulders.)

October 5th, 1874. Sturgeon creek, near its junction with the Assiniboine river, has no regular channel, the ground on all sides being cut up with sloughs. It is evidently a serious torrent, when swollen. Elevation of water level of Sturgeon creek, at bridge, about half a mile from Assiniboine river, 90.96 above datum. Elevation of water level of Assiniboine river, at mouth of Sturgeon creek (the boundary between the parishes of St. James and St. Charles), 83.34 above datum.

October 8th, 1874. Elevation of water level of Assiniboine river at the crossing of the "Winnipeg meridian," in the parish of Headingly, 94.50.

October 9th, 1874. Elevation of bank of Assiniboine river, at lots 202–203, in parish of St Francis Xavier, is 122.55. Elevation of top of secondary bank is 114.00, and elevation of water level of river at same point is 99.01 above datum.

October 13th, 1874. Exposure of north bank of Assiniboine river, near church of St. Francis Xavier:

12"	Decayed leaves and mould.
27"	Sand and clay, mechanically combined.
6"	Sand and mould—mould predominating.
80"	Sand and clay—clay predominating.
6"	Lime and sand.
9"	Sand and clay—sand predominating.
12"	Clay and sand—clay predominating.
48"	Clay and sand—equal mixture.
24"	Clay and a little sand.

Pure sand—bed of river.

Elevation of the top of bank five (5) chains below St. Francis Xavier church is 121.67. Elevation of water level of river Assiniboine, at same point, is 102.95.

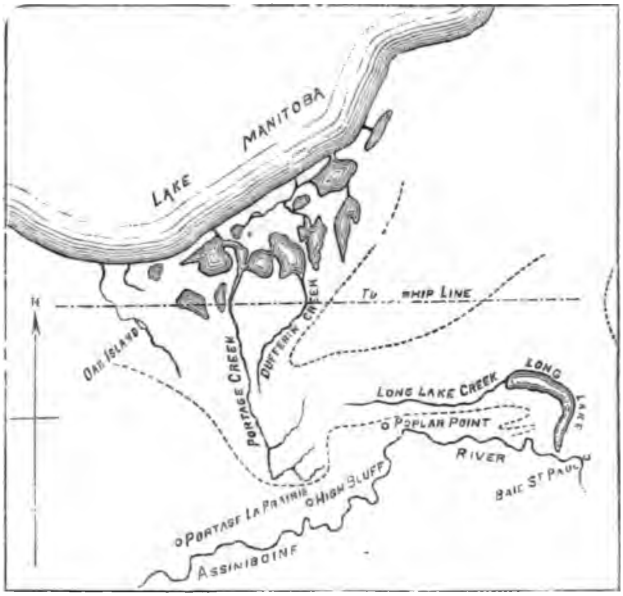
October 20th, 1874. In lot 230, in Parish of Baie St. Pauls, the top of bank of river Assiniboine is 132.67 in elevation above datum. Elevation of water in river at same point is 117.15.

October 24th, 1874. Elevation of water-level of Long lake, in parish of Baie St. Pauls, 136.85. Elevation of land 15 chains S. E. from Long lake, 139.44. Elevation of land, 25 chains S. E. from Long lake, 140.04. Elevation of top of bank of river Assiniboine, at center of lot 142, in parish of Baie St. Pauls, 146.28. Elevation of water in river Assiniboine at same point, 134.18.

August 16th, 1875. The valley of the Assiniboine river at Fort Ellice is about a mile and a half wide, with very steep slopes. It seems to be one big marsh, in which any quantity of alders and willows flourish, and in which the winding river flows in its course. The river is nearly as broad and presents the same appearance as it does near Fort Garry. Elevation of B. M. on northwest corner of the Hudson Bay Company's store at Fort Ellice, 822.28.

Valley of the Assiniboine river at Fort Ellice is 220.5 feet deep. Valley of Snake creek, near Fort Ellice, and on an east and west line thereof, is 155.6 feet deep. Valley of Bird Tail creek, about twelve miles from Fort Ellice, and on an east and west line therefrom, is 150.65 feet deep.

I have the honor to be, yours very truly,
H. S. TREHERNE.



Approximate scale of six miles to ½ inch.

SKETCH MAP,

SHOWING THAT PORTION OF THE PROVINCE OF MANITOBA LYING BETWEEN LAKE MANITOBA AND THE ASSINIBOINE RIVER.

NOTE. Dotted lines show approximately the position of high ground.

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Birch Lake	168	78
Birch Island	153	63
Big Fork River	312	222
Big Stone Lake	329	239
Birds of Minnesota, list of	451	361
Birds of Minnesota, the winter	463	373
Blue Earth River	334	244
Black Point	139	49
Books in the library of the geological survey	255	165
Bowstring Lake	284	194
Brown's Valley	329	239
Brachiopoda from Trenton and Hudson River formations	205	115

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Brule River	145	55
Bronzite	118	28
Burlington Bay	117	27
Cannon Ball Bay	147	57
Cariboo Point	139	49
Cariboo Lake	169	79
Cascade River	140	50
Cass Lake	282-392	192-232
Castle Danger	120	30
Chalcopyrite	110	20
Chester Creek	106	16
Chemistry, report by Prof. Dodge	447	357
Chippewa River	332	242
Chlorite	102	12
Chonetes	208	118
Clarke's Bay	158	68
Clearwater Lake	169	79
Collins, Capt. Edwin, on the St. Vincent salt well	257	167
Copper	142-113	52-23
Copper series, layers of	134	44
Coteau des Prairies	404	314
Cottonwood River	334	244
Cow's Tongue Point	144	54
Courses of glacial striæ in Minnesota	383	293
Crow Wing River	310	220
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Crow Wing	103	113
Crystal Bay	113	23
Cupriferous series in Minnesota	475	385
Daniel's Lake	168	78
Dead Lake	368	278
Delessite	109	19
Devil's Track River	144	54
Deronda Bay	150	60
Diallage	146	56
Diamond Lake	356	266
Distribution of forest in upper Mississippi region	294	204
Divide between L. Superior and L. of the Woods	170	80
Divides in the upper Mississippi region	308	218
Dodge, Prof. James A., report on chemistry	357	267
Douglas County, lakes of	358	268
Douglas County, natural drainage of	358	268
Douglas County, topography of	359	269
Double Bay	147	57
Duluth, rocks at	101	11
Eagle Lake	355	265
East Savanna River	312	222
East Battle Lake	367	277
Eclipse Beach	139	49

	REGENTS'.	GEOLOGICAL.
Elevations	344	254
Ely Island	192	102
Embarrass River	196	106
Encampment Island	118	28
English Portage	164	74
Exploration of the terminal moraine in Iowa	388	298
Fanny Lake	168	78
Fish Hook Point	144	54
Fluorite	111	21
Forest Trees in the upper Mississippi Region	291–324	201–234
French River Copper Mine	113	23
Gaseous substances in well-water	263	173
Garrison, O. E. report on the upper Mississippi region	265	175
Glacial Drift and its terminal moraines	371	281
Good Harbor Bay	140	50
Gooseberry River	118	28
Grand Portage Bay	151	61
Granite	173	83
Graphite	155	65
Great Palisades	125	35
Gunflint Lake	171	81
Hatch, Dr. P. L., report of	449	359
Hat Point	152	62
Hawk Creek	333	243
Herbs in the upper Mississippi region	297	207
Heulandite	114	24
Horseshoe Bay	147	57
Hydrology of Minnesota, report on	314	224
Itasca Lake	276	186
Kandiyohi County, Lakes of	353	263
Kawasachong Lake	181	91
Kinichigaquag Falls	107	17
Knife River	114	24
Knife Lake	176	86
Labradorite	101	11
Lac-qui-parle Lake	331	241
Lac Travers	321	231
Lake Itasca	320	230
Lake Winnebigoshish	322	232
Lakes of Minnesota, their number and distribution	339	249
Lake Ripley	352	262
Lake Lizzie	369	279
Lake Minnabelle	352	262
Lake Reno	358	268
Lake Miltona	359	269
Lake Ida	360	270
Lake Cowdrey	361	271
Lake Latoka	360	270
Lake Darling	361	271

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Lake l' Homme Dieu	362	272
Lake Carlos	362	272
Lake Osakis	363	273
Lake Oscar	364	274
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Latitude and Longitude in Minnesota	474	384
Laumontite	101-103	11-13
Leech Lake	323	233
Lester River	112	22
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Leptagynia	208	118
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List of Rocks, preliminary	100	10
List of the birds of Minnesota	474	284
Little Falls	203	113
Little Elk River	311	221
Library of Geological and Natural History Survey	255	165
Long Lake	182	92
Lover's Bay	140	50
Lucille Island	157	67
Lumbering Resources of the upper Mississippi region	312	222
Magnetite	101	11
Manitou River	131	41
Mayhew's copper mine location	161	71
Maple Leaf Lake	176	86
Medial moraine from Coteaus des Prairies to Turtle Mountain	417	327
Meeker County. lakes of	351	261
Mesabi, height of land	166	76
Mesabi iron location	197	107
Minnetonka Lake	349	259
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Minnesota company's gold mine location	188	98
Mississippi River, discharge of	318	228
Miscellaneous publications	94	4
Modified drift and loess	427	337
Moraine, the terminal in Steele, Waseca and Freeborn Counties	384	294
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Mount Josephine	151	61
Morrison's Bay	159	69
Mountain Lake	166	76
Mud Lake	169	79
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Nobles' mining location	191	101
North Fowl Lake	165	75
Norway Lake	356	266
Number of lakes in Minnesota	338	248

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Olmstead's Bar	203	113
Orthis *Whitfieldi*	205	113
Oathis *Sweeneyi*	207	115
Organic impurities in well-water	262	172
Origin of the lakes	341	251
Ornithology, report of Dr. Hatch	449	359
Otter-Track Lake	175	85
Otter.Tail River	336	246
Otter-Tail Lake	367	277
Palisades	125	35
Palæontology	205	115
Pamajigermug Lake	281	191
Parkersville	156	66
Partridge Portage	163	73
Passabika River	112	22
Pelican Lake	369	279
Permanency of lakes	342	252
Phenomena of freezing	345	255
Pigeon River	157	67
Pigeon Point Peninsula	159	69
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Pipestone River	180	90
Plagioclase	157	67
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Pomme de Terre River	330	240
Pork Bay	132	42
Prehnite	113	23
Prairie River	325-201	235-111
Publications of the Nat. His. Survey	93	3
Pyroxene	162	72
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Rainfall, at Minneapolis	315	225
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Redwood River	333	243
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Roberts, Thos. S., List of Winter Birds	463	373
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Salt Well, St. Vincent	257	167
Sandy Lake	200-290	110-200
Sandy Lake River	325	235

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Savannah River	200	110
Saponite	115	25
Section along the Valley of the Qu' Appelle River	343	253
Shrubs in the upper Mississippi region	296	206
Sickle Bay	147	57
Simond's Gold Location	188	98
Silver Creek	118	28
Solids in solution in well water	261	171
South Lake	170	80
South Fowl Portage	164	74
Split Rock River	119	29
Specimens registered in the museum in 1880:		
Geological and Mineralogical	215	125
Zoological	223	136
Archæalogical	252	162
Stilbite	119	29
Streams of the upper Mississippi region	309	219
Strophomena	208	118
Strophomena Minnesotensis	210	120
St. Louis River	200	110
Sucker Bay	114	24
Sugar Loaf Point	132	42
Sucker Lake	177	87
Summary Statement	97	7
Susie Island	157	67
Syenite	177	87
Squagemaw Lake	199	109
Temperance River	134	44
Terrace Point	141	51
Terry, C. M., report on Hydrology	304	224
Terminal Moraines	376	286
Terminal Moraine from Coteau des Prairies to Coteau du Missouri	419	329
Tests of the qualities of water	260	170
Thalite	115	25
The Mississippi River system	318	228
The Glacial Drift	373	283
The Coteau du Missouri	421	331
The Blue Hills and the Mesabi Range	426	336
Thomsonite	131	41
Tischer's Creek	110	20
Trees of Kandiyohi County	354	264
Trees at the White Earth Agency	272	182
Topography of the upper Mississippi region	306	216
Twin Lily Lakes	166	76
Two Harbor Bay	121	31
Two Islands	133	43
Upham, Mr. Warren, report of progress	371	281
Upper Mississippi Region	265	175

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Value and Utility of Lakes	347	257
Vermilion Lake	186	96
Wauswaugoning Bay	153	63
Washington Lake	352	262
Water Supply of the Red River Valley	256	166
West Battle Lake	366	276
Whetstone River	329	239
White Rose Vein of Silver	167	77
Wild Rice River	312	222
Wild Swan River	325	235
Willow River	310-326	220-236
Winter Birds, list of	463	373
Winnebegosis Lake	283	193
Winston	194	104
Wright County, Lakes of	350	260
Yellow Earth River	330	240
Yellow Medicine River	330	240
Zeolites	142	52
Zoological Specimens in the Museum	226	136

ERRATA FOR THE GEOLOGICAL REPORT FOR 1880.

[NOTE—These errata may be made in the Regents' Report by adding 90 to the paging given below.]

Page 11. At the end of the eleventh line add, vide No. 42.
13. Fourteenth line—for *nearly*, read mainly.
17. Fourteenth line—for *heavy-dark*, *green*, read heavy, dark-green.
21. Twenty-first line—for *their*, read thin.
21. The third line should be the first line.
41. Thirty-second line—for *and igneous*, read igneous and.
42. Thirteenth line—for *easily*, read evenly.
43. Thirty-fifth line—for *drift*, read dip.
46. Twentieth line—at the end of the line add, (?).
48. Next to the last line—after "up" insert, almost entirely.
49. Twenty-first line—for *Branch*, read Beach.
54. Lines thirty-four and thrity-six—for 314 and 315, read 214 and 215.
55. Tenth line—dele paragraph and read, No. 214 is of similar rock, etc.
56. Twelfth line—for *north*, read mouth.
60. Eighteenth line—for *there*. read these.
63. Fourteenth line—for *161*, read 261.
72. First line—for *(No. 5)*, read (N. & S.)
78. Next to last line—for "¼" read ½.
80. Thirteenth line—after "Duncan's lake," insert is.
82. Last line—for *927* read 727.
105. Twenty-sixth line—for *Vermilion Lake* read Lake Superior.
122. Next the last line—for *—3522 (199)* read 3522 (—199).
170. Thirtieth line—for *organic of the*, read of the organic.
224. Fourth line—for *is* read are.
224. Thirteenth line—after *raised* insert it.
234. Twenty-first line—for *from* read join.
288. The first four lines should be inserted before the last line on page 287.
337. The foot notes should exchange places.
390. The last two lines should appear as a heading, to explain the diagram on the next page.

Several minor errors will easily be corrected by the reader.

PLATE I.

Fig. 1. Old Fortification or Camp, Town 135 N., Range, 34 W., about sec. 27.

Surveyed in 1869, by O. E. Garrison.

Fig. 2. Diagram of Pokegama Falls, in plan (A.) and section (B.) The numbers in "B" refer to samples of rock transmitted with the report.

O. E. Garrison, 1880.

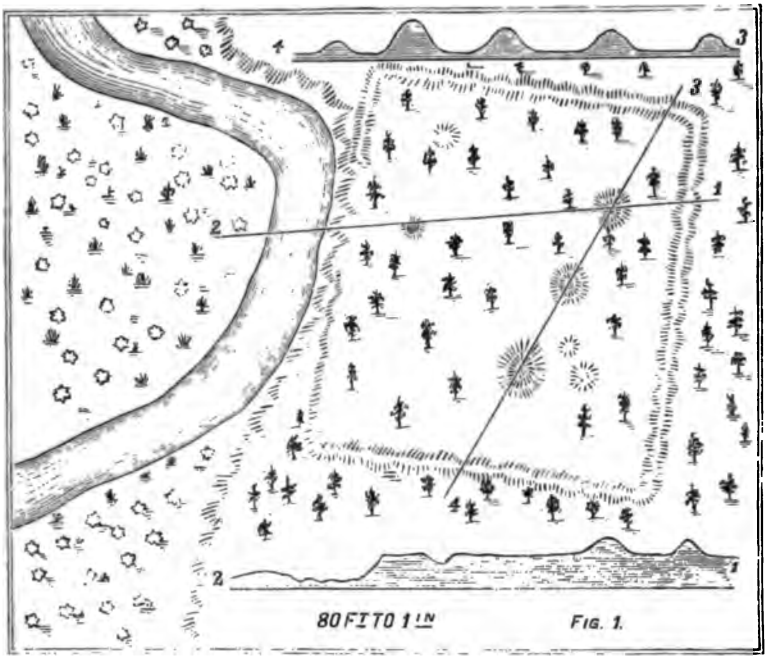


Fig. 1.

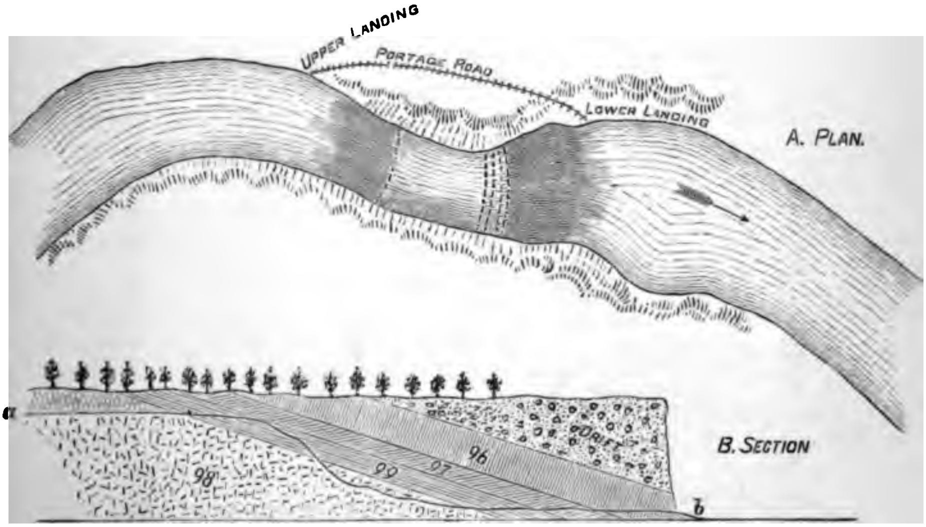


Fig. 2. — Pokegama Falls.

PLATE I.

PLATE II.

Fig. 1. Prairie River Falls. Town 56 N., Range 25 W., 4th Mer.

Fig. 2. Section below the mouth of the Prairie River on the bluffs of the Mississippi. 1. Sandy loam. 2. Pebbles and small boulders. 3. Light colored fine sand. 4. Yellowish sand banded with reddish layers and river mud, and having springs of water. 5 and 6. Red and blue clays. 7. Boulder clay.

Fig. 3. Bed of stratified clay shown in section of the bluff of the Mississippi below the mouth of Sandy River. (a.) unstratified clay; (b.) stratified and jointed clay; (c.) like Fig. 2.; 1 and 2, surface of water in river.

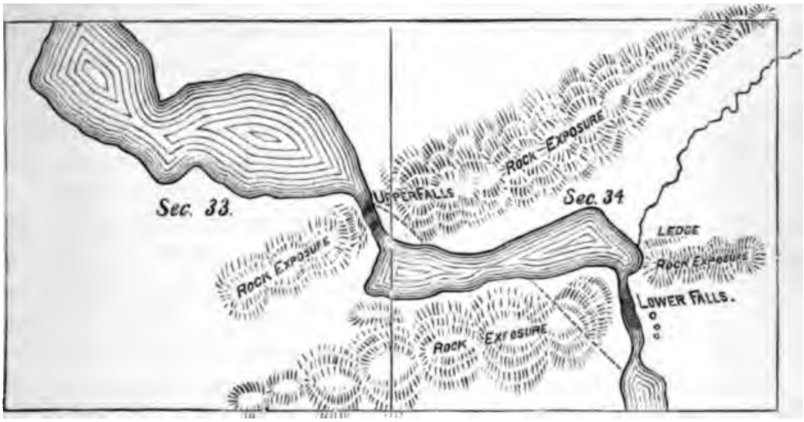


Fig. 1

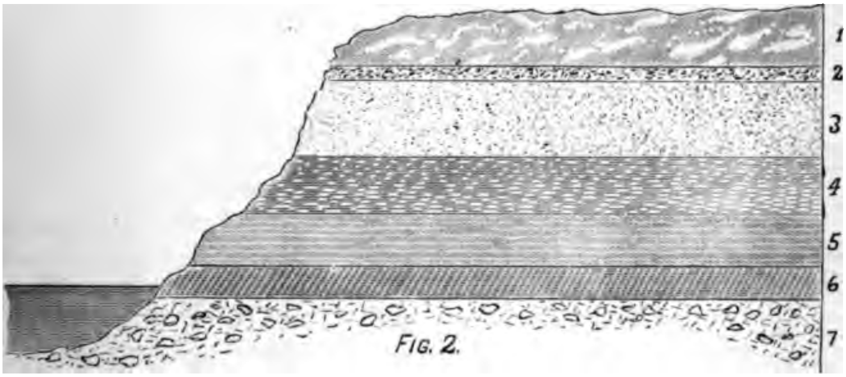


Fig. 2.

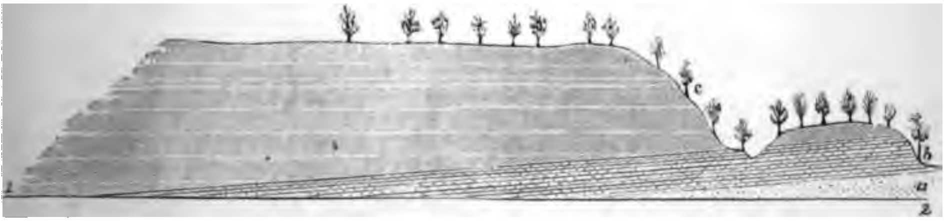


Fig. 3.

PLATE II.

PLATE III.

Sections across the Mississippi and Minnesota valleys:

No. 1. Transverse section of the Minnesota valley at Big Stone lake.

No. 2. Transverse section of the Minnesota near Mankato.

No. 3. Transverse section of the Minnesota at Fort Snelling.

No. 4. Transverse section of the Mississippi valley below Fort Snelling.

Numbers in the vertical scale show heights above the sea.—*[From Warren's Report on Bridging the Mississippi.]*

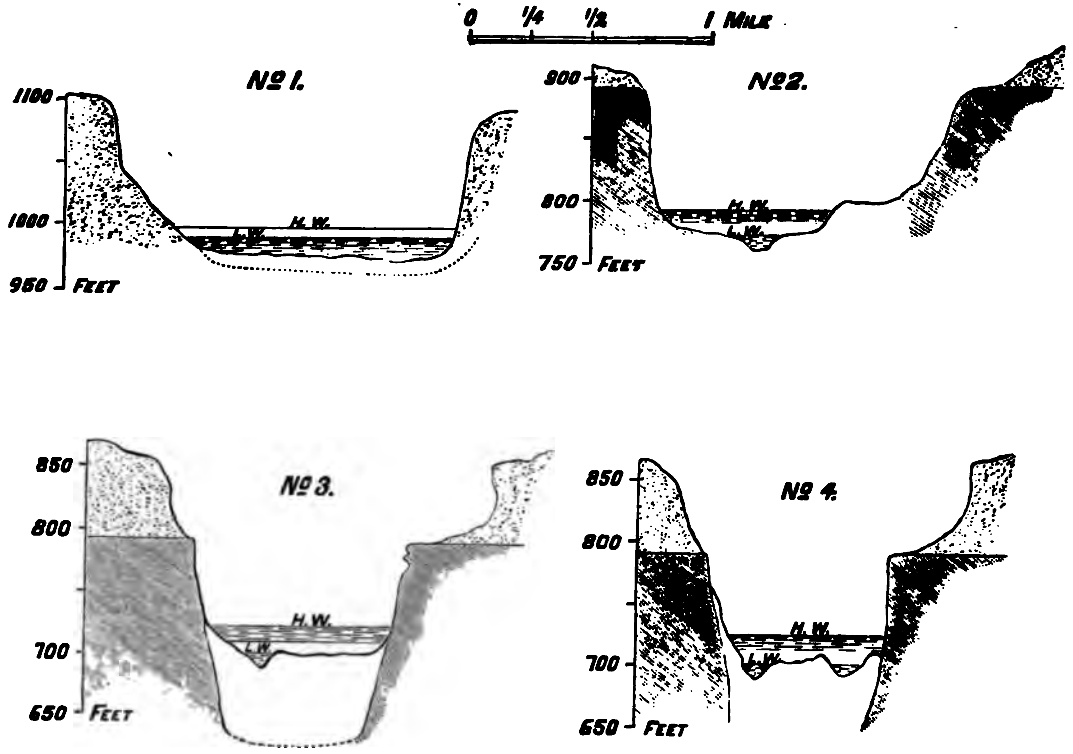

0
1/4
1/2
1 Mile
No 1.
1100
1000
950
Feet
H. W.
L. W.
No 2.
900
800
750
Feet
H. W.
L. W.
No 3.
850
800
700
650
Feet
H. W.
L. W.
No 4.
850
800
700
650
Feet
H. W.
L. W.

PLATE III.

PLATE IV.

Sections across the Mississippi and Minnesota valleys:

No. 1. Transverse section of the Mississippi valley above Fort Snelling.

No. 2. Transverse section of the Mississippi valley at Hastings.

No. 3. Transverse section of the Mississippi valley at Lake Pepin.

Numbers in the vertical scale show heights above the sea.—[*From Warren's Report on Bridging the Mississippi.*]

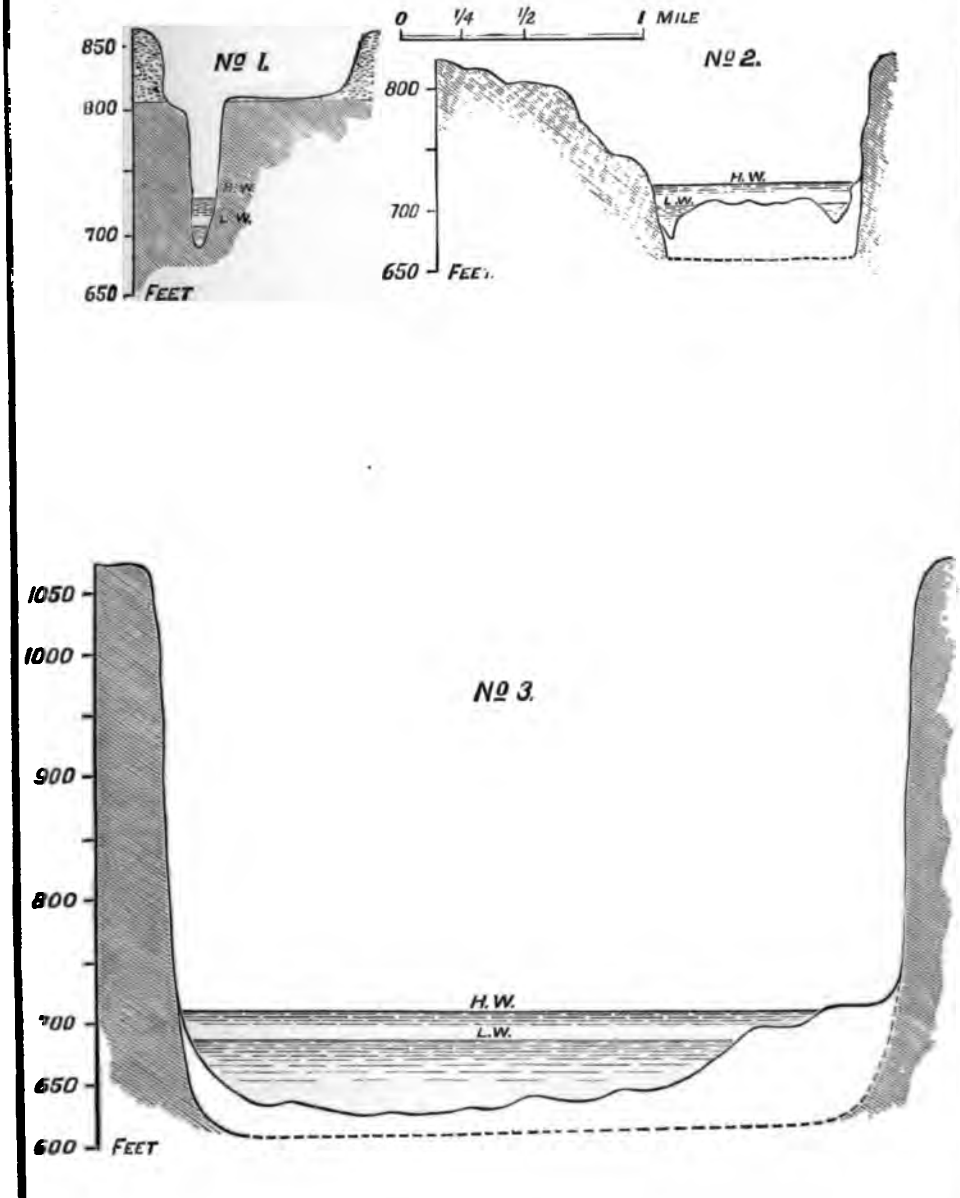
850
800
700
650
FEET
Nº 1.
H.W.
L.W.
0
1/4
1/2
1 MILE
Nº 2.
800
700
650
FEET.
H.W.
L.W.
1050
1000
Nº 3.
900
800
700
650
600
FEET
H.W.
L.W.

PLATE IV.

PLATE V.

The upper Mississippi region reduced from a map by O. E. Garrison:

Explanation.

a. Line north and east of which the characteristic tree is the white pine.—*P. Strobus.*

b. Line including a region in which the characteristic tree is the white pine.—*P. Strobus.*

c. Line including a region in which the characteristic tree is the black pine.—*P. Banksiana.*

d. Line surrounding a tract in which the characteristic tree is the white cedar.—*Thuja occidentalis.*

‖. Granite outcrops.

= Sandstone outcrops.

The usual symbol represents hills and bluffs.

PLATE V.

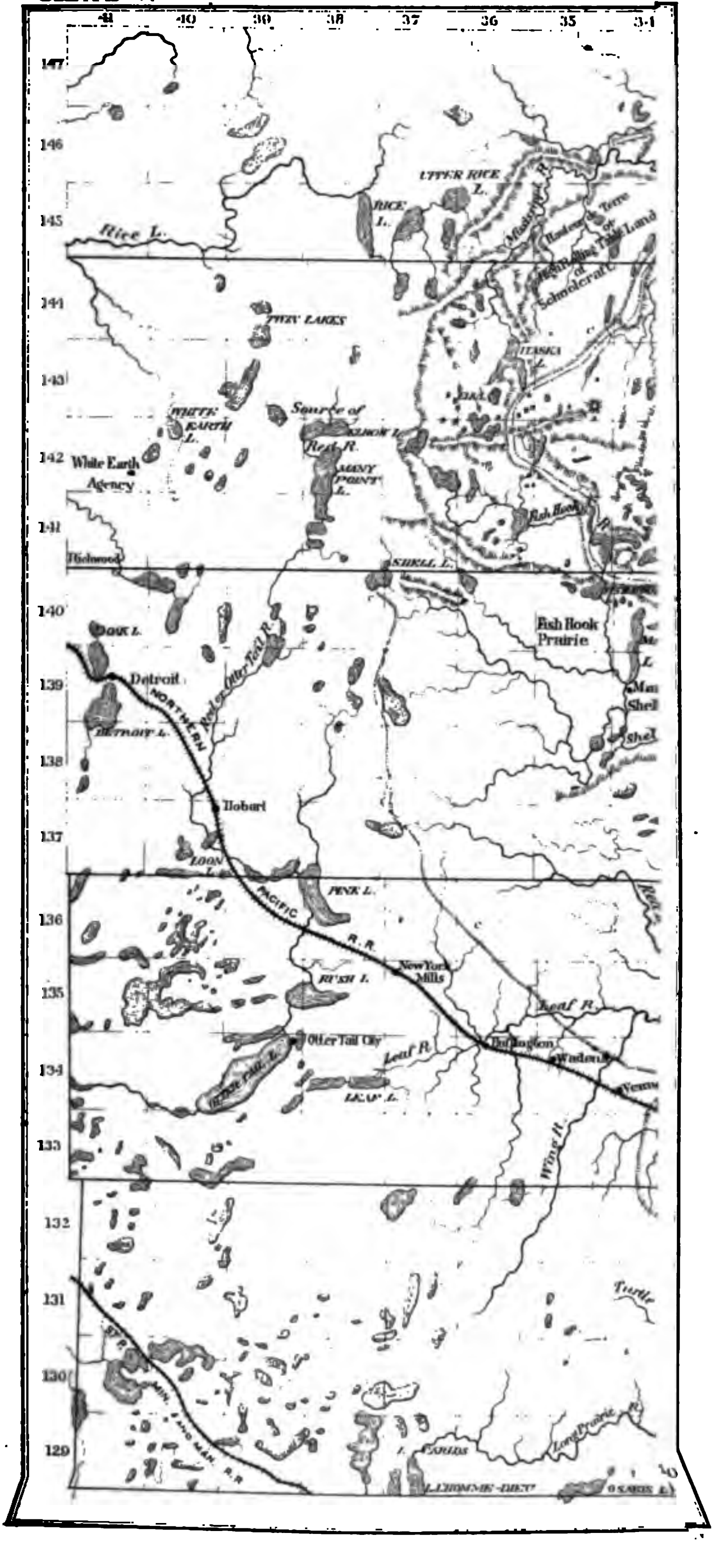

41
40
39
38
37
36
35
34
147
146
145
144
143
142
141
140
139
138
137
136
135
134
133
132
131
130
129
Rice L.
UPPER RICE L.
RICE L.
Mississippi R.
Hauteurs des Terre or Height of Land
Table Land of Schoolcraft
TWIN LAKES
ITASKA L.
Source of Red R.
ELBOW L.
WHITE EARTH L.
White Earth Agency
MANY POINT L.
Fish Hook
Fish Hook R.
Richwood
SHELL L.
Fish Hook Prairie
Shell
OAK L.
Detroit
DETROIT L.
NORTHERN
Red or Otter Tail R.
Hobart
LOON L.
PINE L.
PACIFIC
R. R.
New York Mills
RUSH L.
Leaf R.
Otter Tail City
Leaf R.
OTTER TAIL L.
LEAF L.
Wadena
Wing R.
Turtle
ST. P. MIN. AND MAN. R. R.
Long Prairie R.
L. CARLOS
L. L'HOMME-DIEU
OSAKIS L.

PLATE VI.

The course of the Terminal Moraines, by Warren Upham.

Fig. 1. ***Explanation.*** Terminal and Medial Moraines are indicated by dotted belts; parallel oblique lines mark the Driftless Area; and dotted lines and arrows show the direction of Glacial currents.

Fig. 2. Map of the region of Lakes Benton, Shaokatan and Hendricks. *Explanation.* Terminal Moraine and Glacial Currents are indicated as in Figure 1. The ridge of the moraine is intersected by remarkable channels which extend southwestward from these lakes.

Fig. 3. Section across the Coteau des Prairies in Yellow Medicine county, Minnesota, and Deuel and Codington counties, Dakota.

FIG. I.

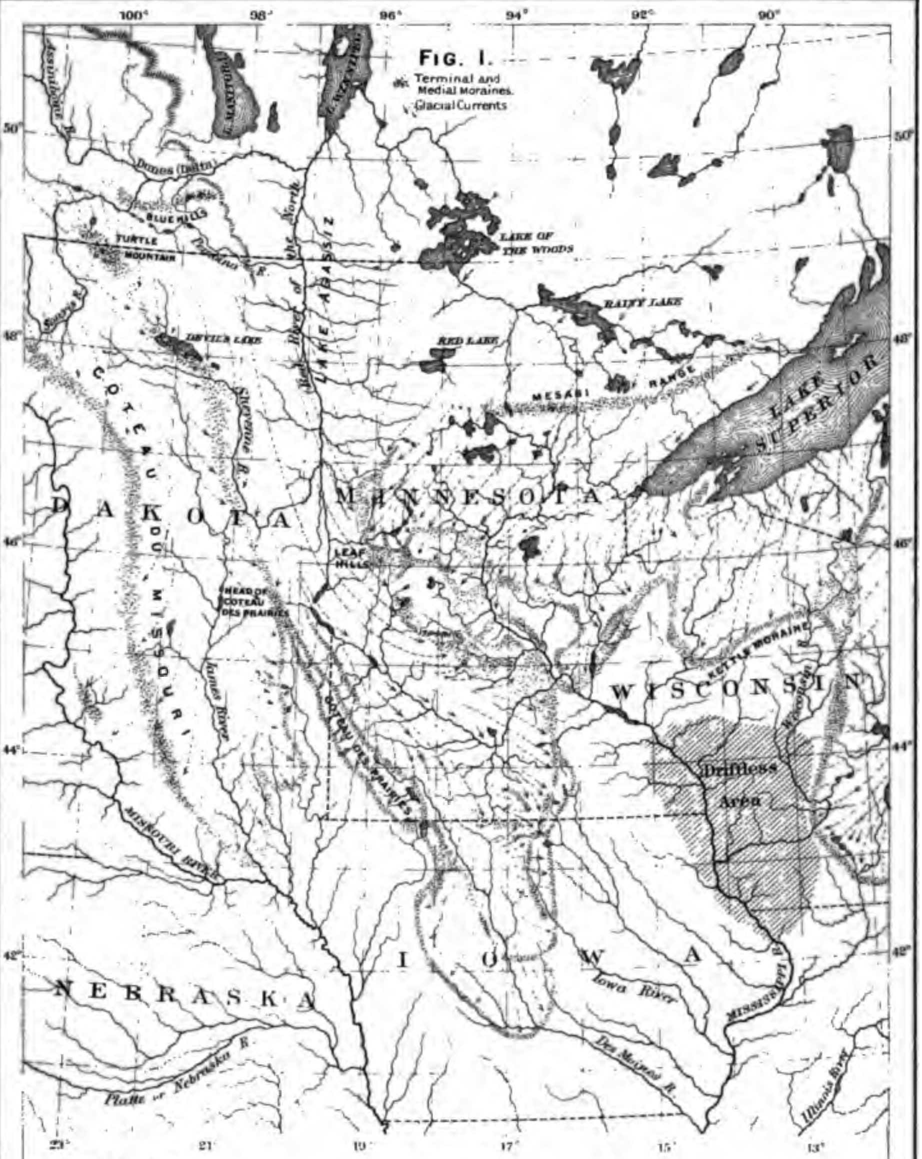


FIG. 2.

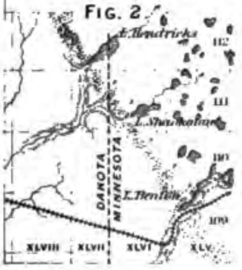
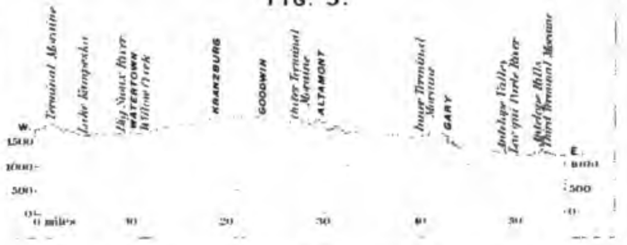


FIG. 3.



JULIUS BIEN LITH. N.Y.

ADDITIONAL ERRATA TO THE GEOLOGICAL REPORT.

[NOTE.—These errata may be made in the Regents' Report by adding 90 to the paging given below.]

PAGE 12, line two, for *this* read their.

21, line twenty-nine, for *east the of* read the east of.

29, the third line should be first.

35, line 15, after *east* insert side.

49, line thirty two, for *alterations* read alternations.

83, line seven, for *kine* read kind.

115, line two, for *Brachipoda*, read Brachiopoda.

115, last line but one, for *large* read larger.

118, line tweuty, for *Orthisidal* read Orthisidæ.

120, last line, for *Jams* read James.

177, line thirty-four, for *sec.* read town.

179, line two, for *pieces* read pebbles.

179, line 32, for *one mile* read one-half mile.

184, line two, for *discovering* read descending.

185, line four from the bottom, take out the superfluous word *end*, and insert of lake

193, line fifteen from bottom, for *sand* read land.

194, line six, for *three* miles read three-fourths mile.

194, line five from the bottom, after *leaving*, insert one a short distance below.,

194, last line, after *a* insert more.

205, the paragraph beginning "There are several tracts," should be inserted after the paragraph on page 206 beginning, "West and south of,"

206, in the first paragraph strike out all after the word "interspersed" and insert the following: "The line of dashes separated by two dots (a) indicates the western and southern boundary of the region where the white pine is the characteristic tree, and the northern and eastern boundary of the sandy black pine country; while the line (c) running near the Northern Pacific railroad from near Verndale northwestward, and the line (b) from near Verndale to the southern margin of the map, represent the approximate division between the last and the region of deciduous trees, which extends southward beyond the area of the map.

219, twenty-sixth line, for *a few localities having* read the few localities herein.

223, lines four and five from the bottom, for *five hundred and seventy-six millions* read five thousand seven hundred and sixty millions.

227, twelfth line from the bottom, for *finds* read find.

230, line sixteen, for *necessarily increases importance* read of necessarily increased importance.

230, line seventeen, for *cradles* read cradled.

, line eighteen, for *transport* read transports.

ADDITIONAL ERRATA.

PAGE 232, line eighteen, for 1810 read 1820.
236, line fourteen, for *drains* read dams.
244, line twenty-two, for *three mile* read one mile.
250, the word *not*, end of the twenty-third line, should be at the end of the twenty-second line.
251, line four, after *Li Sueur* insert counties.
269, line seventeen, for *Mohr* read Moe.
275, line four, for *nets* read Mts.
276, line four from the bottom, for *outlets* read inlets.
280, line four, for *emigration* read immigration.
292, twenty-eighth line, for *northern Minnesota* read northern Missouri.
293, fourth line, for *approximating local* read approximately level.
295, twentieth line, omit the comma after before.
296, seventh line, for *Iosca* read Iosco.
296, twentieth line, for *northwest* read southwest.
296, twenty-ninth line, change comma to semicolon after Freeman.
296, thirty-first line, change comma to semicolon after Nunda.
297, twenty-first line, for *conveying* read converging.
297, thirty-eighth line, for 25 read 23.
298, thirty-ninth line, *for cause* read course.
299, twenty seventh and thirty-second lines, read Rhodes' Mill.
299, thirty-fourth line, for *north* read south.
302, thirtieth line, read south-southeast.
304, second line, read south-southwest.
304, thirty-ninth line, for *contains* read continues.
306, first line, read Potsdam.
306, twelfth line, after *east* insert, and by the east.
306, thirty-ninth line, for *glacial action* read glaciation.
307, first line, for *more* read nearly.
307, seventh line, omit *and rivers*.
307, eleventh line, read southward.
308, thirteenth line, for *coast* read course.
308, thirty-third line, for *Grange* read Orange.
311, eighth line, insert western before series.
311, thirty-second line, read Estherville, and for *to* read its.
312, twenty-fourth line, for *lake* read Lake in three places, and generally elsewhere when used as a name of a town or township ; but in its ordinary use as a common noun begin *lake* with a small letter ; thus : *Heron Lake* in speaking of the town, but *Heron lake* when the lake itself is meant.
313, seventeenth line, read west-northwest.
314, read *The Coteau des Prairies*.
314, twentieth line below, read Highland of the Prairies.
315, fourteenth line, read west-northwest.
315, thirty first line, read Potsdam, and same on pages following.
316, sixteenth line, insert comma after side.
317, thirty-first line, for *area* read arm.
318, thirty-seventh line, read north-northwest.
319, first line, for *was* read were.
319, seventh line, for *outlaying* read outlying.
319, twenty-second line, read north-northwest.
319, thirty-first line and elsewhere, for *Warpeton* read Wahpeton.

ADDITIONAL ERRATA.

PAGE 319, thirty second line, for *northwest* read southwest.
320, seventh line, for *Minnesota* read Minneota.
320, thirty-third line, change semicolon to comma after plateaus.
321, thirteenth line, insert lower after feet.
322, twelfth line, for *Ellsworth* read Ellsborough.
323, fourteenth line, for *noted* read eroded.
324, third line, for *T.* 11 read T. 110.
324, twelfth line, read south-southwest.
324, eighteenth line, for *two* read to.
327, eighth line, after *miles* change comma to semicolon; next insert, 'then six miles are moderately rolling, mainly in smooth swells.'
328, fifth line, read 46 deg., 30 min.
328, sixth line, read elsewhere; read Head of the Coteau.
329, in first foot note, read 1878; p. 62.
332, eighteenth line, read coteaux.
332, in second foot note, read *Territories*.
333, thirty-first line, read Dawson.
333, thirty-fourth line, for *drifts* read drift.
333, thirty-sixth line, after 120 insert miles.
334, sixth line, for *gravel* read gradual.
334, eighth line, for *remarkably* read markedly.
335, thirty-third line, read east-southeast.
336, twenty-sixth line, read Buffalo Pound hill.
337, second line, read Winnibigoshish.
337, sixth line, for *the terminal* read this terminal.
337, tenth line, for *coteau* read Coteaus.
337, seventeenth line, for *high* read deep.
337, lower part, fourteenth line, read Hilgard.
338, thirty-ninth line, for *its* read their.
339, twenty third line, for *where* read when.
339, thirtieth line, for *Hillis* read hills.
340, tenth line, read Champlain.
340, nineteenth line, for *from* read form.
340, last line, read overflow.
341, first line, read Lamoure.
341, last line, read east-southeast.
347, near bottom, read Iroquois.
351, first line, for *Fairfield* read Farley.
351, twelfth line, read Blairsburg.
351, fifteenth line, Duncombe.
352, twenty-seventh line, read Corwith.
352, seventh line from bottom, read Blakely.
353, twelfth line, read Madelia.
355, near top, after Becker insert county.

No errors of printing occur in the lists of figures stating distances and heights, on pages 345 to 356.

PAGE 359, twelfth line, for *Virtell* read Vieill.
360, sixteenth line, for *north* read now.
361, thirtieth line, for *White-billed* read White-bellied.
362, first line, for *Red-billed* read Red-bellied.

ADDITIONAL ERRATA.

PAGE 365, twenty-third line, for *Tryemalis* read hyemalis.

367, ninth line, for *Yellow-billed* read Yellow-bellied.

369, the second No. 201 should read 201½.

372, the second No. 269 should be 269½.

374, foot note, second line, for *Cone's* read Coues'.

375, line two, for *carioliaensis* read *carolinensis*.

376, line one, for *Tripple* read Trippe.

376, line thirty, for *Bys* read (*Linn.*) *Bp.*

376, line forty-four, for *whenever* read wherever.

377. line eleven, for *Shpyrapcius* (*varions*) read (*Sphyrapicus varius*).

377, line sixteen, for *hole* read bole.

377, line thirty-two, for *Bys* read *Bp.*

377, line thirty-four, for *Bys.* read *Bp.*

377, line thirty-seven, the *e* in *Chrysaetus* should have two dots above it.

377, line forty-one, the *e* in *Haliaetus* should have two dots above it.

378, line seventeen, for *northern* read southern.

379, line eleven, for *just* read thus.

379, line fourteen, for *Evering* read Evening.

379, line twenty-eight, for *wawing* read waxwing.

380, line fifteen, after crimson supply spot.

380, line sixteen, for *rare red plush over the entire heart* read rose red flush over the entire breast.

380, line thirty-four, for *ends* read seeds.

382, line 12, for *have* read brave.

382, line thirty-four, for *Sol.* read *Scl.*

382, line thirty-seven, for *Rud.* read *Aud.*

383, line ten, for *Stearns Co.* read Meeker Co.

383, line thirty, for *Tengmalius* read Richardson's.

In the index, p iii, first line, for 344 read 434 ; and for 254 read 344.

In the index, p. iv, for *Coteaus* read Coteau.

In the Index, p. vi, third line, for 343 read 433 ; and for 253 read 343.

On the next page, omit the errata for pages 288 and 337.

THE GEOLOGICAL

Presented to

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By N. H. WINCHELL,
State Geologist of Minnesota,
Minneapolis, Minn.

On behalf of the Regents of the University.
Contributions to the Museum and Library are solicited.

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THE TENTH ANNUAL REPORT,

FOR THE YEAR 1881

N. H. WINCHELL,

STATE GEOLOGIST.

1

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1882.

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ADDRESS.

To W. W. FOLWELL, President of the University.

DEAR SIR:—The accompanying report gives a summary of the work of the Geological and Natural History Survey of the State during the year 1881, being the tenth annual report. In thus rounding a complete decade of consecutive annual reports on the Geology and Natural History of the State, I think, sir, that the University and the State may be congratulated on the success which has attended the enterprise, a large share of which is due directly to the wise provisions of the law by which the survey is carried on, as conceived by yourself in 1871.

Respectfully submitted,
N. H. WINCHELL,
State Geologist and Curator of the General Museum.
The University of Minnesota, Minneapolis, December 31, 1881.

REPORT.

I.

SUMMARY STATEMENT.

The field work has been continued by Mr. Upham, aided in July and August by Mr. H. V. Winchell. The field of examination has been the north-central and northwestern portions of the State. These counties are almost entirely covered with a heavy sheet of drift, and necessarily, most of the recorded observations and investigations have related to the surface geology, and a large fund of valuable information has been added by Mr. Upham to the historical geology of the Quaternary Age. That ancient body of inland water which in former reports has been styled *Lake Agassiz*, has been found to have extended its highest shore line far toward the east, in the northern part of the State, probably including within its limits the present Red and Rainy lakes, and the Lake of the Woods, giving the well known topographic features of the Red River Valley, to a much larger extent of territory in Minnesota than had formerly been supposed, even quadrupling the known area pertaining to the valley as heretofore limited. Not only is this a valuable accession to the known agricultural capabilities of Minnesota, but the results attained in other directions, are equally valuable to science. The beach lines of Lake Agassiz have been subjected to a careful inspection over a distance north and south of about one hundred and seventy-five miles, resulting in the discovery of some peculiarities which have a direct bearing on their formation and history, and aid in filling out an obscure chapter in the geology of the Ice Age Some of these peculiarities may be mentioned briefly.

The lake had three stationary periods, forming three beaches. They all ascend above a given datum level toward the north, the rate increasing in going toward the north. The highest beach line ascends one hundred and twenty-five feet in about one hundred and fifty miles, the beach being one continuous shore line. The northern portion of the lake fell at intervals from this high beach-line, forming lower beaches successively at about eight, fifteen, thirty, and forty feet, while the water level in the extreme southern part stood nearly stationary, the northern fractional beaches converging into one toward the southern extremity of the lake. The next distinct beach found in the southern part of the region ascends toward the north seventy feet in one hundred and fifty miles. The surface of the lake had now fallen thirty feet in Traverse and Grant counties, fifty feet in northern Clay county, and ninety feet northwest of Maple lake. The fall of the lake had therefore been sixty feet more at the northern than at the southern end. Double and multiple ridges occur along the northern half of this distance. The third beach-line, formed when the outlet had been excavated to the level of Lake Traverse, is known along a distance of one hundred and thirty-five miles, and its northward ascent was at first fifty feet and and afterward only about twenty-five feet. Toward the northern extent of this beach are also additional lower beaches, indicating a halting descent of the water level. The fall of Lake Agassiz from the highest beach level to the third, at Lake Traverse, was about eighty feet, and in the vicinity of Maple Lake one hundred and sixty-five feet. But the rate of ascent of this third beach-line is less in the northern portion than toward the south. These phenomena seem inconsistent with that hypothesis which supposes an elevation of northern land as a barrier to contain this vast inland lake, inasmuch as these beaches would have to present a slope in the opposite direction in order to change the outlet from Lake Traverse to Hudson's Bay. The same kinds of beaches appear about the southern shores of Lake Erie and Michigan, and have often been referred to in geological reports They have been ascribed to the operation of the glacial period in the epoch of its decline, when the ice still existed toward the north as a barrier to prevent northern drainage. The same obstruction must have existed in the Red River Valley, and in the opinion of Mr. Upham, its attraction was sufficient to move the mass of the water toward itself and to cause an ascending shore line in that direction. Any such barrier, operating inversely as the squares of its distance from different parts of the lake, would thus cause a more rapid ascent in those portions of the shore line near it than in those more remote.

Lake Agassiz, probably covered Red Lake under fifty or one hundred feet of water above its present level, Lake of the Woods under about two hundred feet, the Red River Valley at St. Vincent, four hundred and fifty feet, and Lake Winnipeg, about six hundred feet. It is supposed to have extended east as far as the east end of Rainy Lake, but no definite statements can be made yet concerning the northern slope of the State between Red Lake and Vermilion Lake.

The distribution and characters of the crystalline rocks in the central portion of the State, including the counties of Stearns, Sherburne, Benton, Morrison, Mille Lacs, Kanabec, Aitkin and Todd, and portions of Carlton and Pine, have also been ascertained by Mr. Upham.

The failing health of Mr. C. M. Terry, rendered it necessary for him to suspend active work about the middle of May. A trip to Florida afforded him no relief, still he was preparing to resume work on the survey in the latter part of summer. when he was taken worse and he died.

His contribution to the last report of progress, pertaining to the Hydrology of the State, shows the carefulness and the scope of his work. His perseverance and industry were remarkable, and the amount he accomplished, with his feeble health, was a surprise to those who knew the obstacles under which he labored. He has left some maps, notes, and incomplete manuscript, which will be made to contribute in his name, to the completion of the subject to which they pertain. I cannot forbear at this place, giving testimony to his uniformly, cheerful disposition and urbane personal bearing, his high integrity, his zeal and industry, and his truly scientific methods of work and thought. Having spent some years in the christian ministry, one of the most instructive facts of his brief labors for the survey, is the ease and quickness with which he turned himself to purely scientific pursuits. He began with careful laboratory work, requiring patient mechanical manipulation, and he succeeded from the outset. Whatever he undertook, he knew how to accomplish at once. Having a trained mind, it was no task for him to apply it vigorously and persistently, in a new field of labor. A general suggestion, or an intimation as to the direction to be given to his labor, was all that was necessary. Had he been able to finish the work that he had in hand, one of the most useful, thorough and instructive chapters of the final report of the survey would have been written by him.

Mr. C. L. Herrick continued to work in the laboratory of the survey and in the Museum, till the first of July. He sailed for Europe in September, and is studying in Leipzig. A contribution of his to the survey reports has been under way ever since the publication of his paper on *Microscopic Entomostraca* in the seventh annual report.

My personal labor has been given to the preparation of chapters for the final report, which, with the prosecution of the building-stone investigation, the office and executive duties, and the conduct of the last annual report through the press, have occupied my whole time. It has been necessary to visit most of the quarrying localities in order to obtain samples of suitable size for use in the examination of the building-stones of the State. At the same time the quarrying statistics of the State were furnished the U. S. census for 1880, and additional samples were forwarded to Washington to be subjected to a careful analytical examination by the government, calculated to further elucidate the nature of the rocks of Minnesota.

In the Museum report will be seen the recorded additions to the collections, and their sources. No important purchases or changes have been made either in the material of the collections or arrangements of the Museum rooms. There will be no occasion to make important changes before the erection of the new building for the use of the Museum, which has been ordered by the State legislature. Indeed, it would be poor policy to lay out much more expense on the old rooms. In the new building it is expected better accommodations will be afforded not only for the exhibition of the specimens, but also for the handling and examination of the various classes of rocks. The thanks of the University are due to Col. J. B. Clough, for fossil specimens of extinct vertebrates from Montana, and for Indian implements, for the General Museum, and for other specimens, and to O. E. Garrison, for procuring samples of water from Mille Lacs; and to Dr. —— Miller, of the Little Missouri Cantonment, for a collection of fossil leaves from that locality.

The survey is also under obligations to Prof. A. H. Chester, of Hamilton College, N. Y., for a report on the geology of the iron region east of Vermilion Lake, based on observations made by him during two seasons spent in that part of the State exploring for iron in the interests of non-resident capitalists. The report of the survey for the year 1878 called attention to the existence of iron ore in the northern part of the State in large quantities, and to the fact that parties interested in iron from eastern States have made costly surveys and examinations, attesting the value of these deposits by field exploration, and by laboratory assay. Since then others have become interested in the same way, and it is not premature to predict that the iron ore of Minnesota will, not many years hence, be largely wrought, and yield to the State a revenue which will be commensurate with the extent of the deposits and the importance of such industry. It would be well if the capatalists of Minnesota would look after this matter, and by concerted action, retain within the State as much as possible of the profits of such development of these ores. The blast furnace which is now in operation at Duluth, using ores from Marquette, should be supplied from Minnesota, and Minnesota railroad companies should see to it that these ores are made accessible. Our iron ores are the farthest west of all the Lake Superior deposits, and being in the midst of timbered lands are situated favorably for reduction by charcoal; while the great region west and northwest, destitute of the rocks producing these ores, will always have to depend on us for iron and its products in the same manner as for lumber. Eastern iron deposits and eastern furnaces should not be allowed to find it profitable to send their products past our doors when we have every requisite and every facility for producing the same. It would be a thing highly creditable to the Regents and to the University, to be directly instrumental in developing this great industry, and I hope that general attention may be called to its feasibility.

I wish to call your attention again to the destruction of the forests by fire in the northern portions of the State, and to refer you to representations made in the report for 1878, (p. 24) and again in the report for 1879, (p. 134). The Legislature should be asked to enact the necessary laws, with penalties, to preserve the forests, and especially the pine forests, from destruction. These fires are not occasional, but seem to be habitual. No country in the world, claiming to be a civilized and enlightened commonwealth, should permit such wanton destruction of the public domain for one moment when once informed of it, and it would not be possible were it not for the sparseness of the inhabitants, and the indifference to the public interests too often exhibited by republican Legislatures. It would be well if co-operation could be had with the Canadian government in any effort to suppress these fires, since they originate on both sides of the international boundary. The The University pine lands, on the St. Louis river, are annually in danger of being devastated.

II.

PRELIMINARY LIST OF ROCKS

COLLECTED BY N. H. WINCHELL IN 1879—CONTINUED FROM THE LAST REPORT.

FROM FOND DU LAC TO KNIFE FALLS.

443. The red sand rock at Fond du Lac. This dips E. S. E., or S. E., about ten degrees.

443A. Quartz pebbles from No. 443.

444. About the center of S. W. ¼, sec. 6, 48, 15. Here a bed of dark-red shale strikes across the bluff. This is about eighteen feet thick, and has thin beds of sandstone occasionally, much as the limestone is embraced in the shales of the Hudson river formation. This shale has spots that are greenish. Pieces of the same color (and also red) are sometimes seen in the midst of the massive sand rock (443) which, on weathering out, (where quarried,) give the rock a loosely porous and (apparently) conglomeritic structure. There are belts and thin strips, parallel with the bedding, that are conglomeritic with white, or glassy (not milky,) water-worn quartz pebbles, that are sometimes larger than hen's eggs, but the great mass of the whole is a homogeneous sandrock. They are sometimes more shaly, and also on separating some of the thin layers, they even show micaceous interlamminations. The general color is a dark red-brown, like the brown sand rock of the "brown fronts," but it has layers that are of the ordinary light-colored sand rock. This light color is sometimes disseminated through the red in round spots or specks, or is clouded and mottled in it over considerable areas. Sometimes a solitary quartz pebble, as large as a walnut, is seen in the otherwise homogeneous brown sand rock; and occasionally one is as large as a man's fist.

Below the above-mentioned bed of dark-brown or red shale, the rock is altogether less firm and siliceous than it is above, or to the east. After a thickness of about twelve feet of rock, somewhat like the rock overlying, another bed of shale, or shaly rock, is met with, whose extent cannot be defined, as it seems to alternate with thin bands of shaly sand rock confusedly, the latter having cross-stratification, until finally the whole formation, so far as seen in the bluff, almost deserves to be styled a shale. It resembles the red shaly sand rock of Good Harbor Bay, near Grand Marais. It sometimes weathers out in slates, (less than one-fourth inch thick) which are flexible, and red like the rest, but rather fragile. It has belts of green shale running parallel with the bedding. There is a thickness of about thirty feet of this shale visible along the river by the railroad, before it is hid again by trees and talus. It becomes all shale. The apparent horizontality is due to a change of direction in the bluff. Some of it is quite siliceous, but in very thin sheets. The brick-red color is sprinkled with light spots; and there are belts, three or four inches thick, of a light bluish-green color. The green color, indeed, seems to be the original color, and prevails largely on tearing down a lot of the layers. Although following the layering in belts, or elongated with the bedding, yet these light-green spots are also globular, or oblate spheres passing through several sheets of the thin shale, which shows no change but that of color.

At the high bridge, "No. 1," which is over a little creek at center of sec. 1, 48, 16, the formation shows about the same dip, but is more nearly a sandrock again, but still with alternating layers of slaty sandrock, (often with cross-bedding,) and red aluminous shale in thin layers; but where the creek joins the river there is a bed of about three and one half feet of red, crumbling, conglomerate. This lies below the shale last mentioned, and has below it an exposure of about six inches of cross-bedded sandrock. Thus, in ascending the creek, the layering is as follows, No. 1 being the lowest:

1.	Cross-bedded sandrock, next the water	6 in.
2.	Crumbling conglomerate, rather fine	3½ ft.
3.	Shale, with layers of six and eight inches of shaly sandrock with cross-bedding	4 ft.
4.	Shale	18 in.
5.	Sandrock	8 ft.
6.	Like No. 3	12 ft.
	Total	29 ft. 6 in.

The above section is all on the lower side of a *fault*, i. e., on the river side, and on the left bank of the creek. Above the fault, which is hid on the opposite side of the creek, the visible section consists of the following:

1.	Crumbling conglomerate, rather fine	3½ ft.
2	Shaly sandrock, with belts of greenish, shaly sandrock and of shale	10 ft.
	Total	13½ ft.

It seems as if the conglomerate had passed up to the upper level, a distance of about fourteen feet, but there are fractured and curved beds at the fault, indicating a subsequent settling again of about six inches, after the fault had closed up.

446. Black roofing slate, near the section line, between 30 and 31, in town 49, 15, in the bottom of a branch of Mission creek, very inconspicuous exposure, covered in high water. The slaty cleavage strikes across the creek east and west.

447. Nearly on the town line, next south, below the two forks from the northwest, in the bottom of Mission creek. This is a lighter colored slate than the last, but related to it closely. It strikes in the same direction and rises about four feet in the right bank of the creek.

448. Crumbling, red conglomerate, from the tilted beds of the St. Louis, at a point near the bridge ("No. 1,") over the creek mentioned, but lower in the formation than the three and a half foot bed. This bed is fifteen feet thick, shows a strong dip, and is underlain, in ascending the creek, by two feet of shaly sandstone, and then by fifteen feet of shale not well exposed. Under that, still higher up the creek, may be seen six feet of red conglomerate descending below the turf, and extending along the bank so as to make, with the dip constant, about fifty feet.

449. Below the last appears this number, which is a hard pyritiferous, pebbly conglomerate, consisting largely of quartz pebbles. This is seen on S. W. ¼ of N. E. ¼ Sec. 1, T. 48, 16. It dips with the red beds, about 10° E. of S., by compass. Some of the pebbles are two or three inches across. The pebbles are mainly of milky quartz. Some are translucent. Some are black or gray. In some places nearly one-half of the gravel is of the underlying slate formation. Just above the junction of the two creeks there is a blind vein of calcite about two inches thick, running north and south in this conglomerate. The conglomerate extends a few rods along the creek, both branches, and before it disappears, which it does by rising in an incline along the left bank in accordance with the dip, it shows about eight feet of bedding; and within the distance of about two rods the Thomson slate formation appears in the bed of the creek, and soon form a considerable exposure along the bank. The slates stand nearly perpendicular as the weathering separates the cleavage planes, and they strike east and west, as at Thomson. But it seems as if the conglomerate lies lower where it is last seen in the bed of the creek, than the slate when it first appears, and so low that even with the dip, which would of course tend to throw it higher in ascending the creek, it could not get over

the slate. Hence it is probable that the conglomerate lies in depressions in the slate surface, and is thicker in some places than in others. At this place the contact is not visible, but there cannot be much between the points seen on each side. So that, as already stated, there is too much conglomerate to fill the unseen interval. This conglomerate appears conspicuously on the St. Louis, S. E. ¼ Sec. 2, T. 48, 16. (For a complete section of the red sandrock beds, see after No. 510).

450. Samples of the Thomson slate, from the river bank, S. E. ¼ Sec. 2, T. 48, 16, underlying the conglomerate, No. 449.

451. Samples of the same showing, the slaty cleavage transverse to the bedding. The dip of the slate beds is to the S. W., amounting to about four degrees, the conglomerate being unconformable.

452. Slate pencils, formed naturally by the intersection of diffierent divisional planes, having a rhomboidal section. The overlying coarse, gray conglomerate, seems to have a thickneess of about 100 feet. Above that is a considerable red, finer conglomerate, perhaps fifty feet.

453. Slate from the lower falls of the St. Louis river, S. E. ¼ Sec. 10, T. 48, 16.

454. Near the foot of the falls, on the left bank, are several "veins," or folia of white quartz, parallel with the slates, some of which are four to six inches in thickness. They are all in an interval of about three feet, with folia of slate between.

455. Slate embraced between and contiguous to the white quartz.

456. Harsh, arenaceous, gray, firm beds, two to three feet thiok, embraced in the slate at the lower falls, having no slatiness.

457. Slate; average sample for the rock of the lower falls.

The cause of the lower falls is the occurrence of a dyke of igneous rock which crosses the falls near their brink, hardening the layers of the formation. The falls cross the river stragglingly about east and west in conformity with the strike of the formation, and descend about twenty-two feet in the distance of about six rods, but the water is rapidly descending in other short cascades for a quarter of a mile above the falls. Also below the falls it continues as a rapid to the foot of the islands, descending about fifteen feet more. The dip, which is taken to be the general incline of the heavy beds toward the S. E., is 63°, but there is a multiplicity of folia, joints and seams, and sedimentary planes, that all confuse the question of the dip. This measurement was made near the dyke, and on the east side of the river.

458. Hardened slate formation, contiguous to the dyke at the lower falls. The slate here has a coarsely basaltic structure along the east

side of the dyke. The columns run E., S. E. and dip about thirty degrees from the horizon.

459. The doleryte dyke at the lower falls, by compass, runs N. N. E. and is at least twenty feet wide. It may be twenty-five feet, but the high stage of water prevented a full view of its western extent. This has so hardened the slates that they are more durable under the action of the river than the dyke itself.

460. Above the falls, nearly opposite Island No. 6, (the islands being numbered up stream,) two other dykes are seen on the east shore, the rock being of the same kind as the large dyke (459), but finer grained. One seems to be about eight feet and the other about ten feet wide.

461. Sample from the eight-foot dyke.

Above the lower falls, along the east side of the next island, the rock stands up in the channel as very rough islands, the water descending about twelve feet near the lower end, and about nine feet near the upper end of the island. The fall near the upper end of the Island No. 5, is due to the occurrence of a rather soft and fissile layer of the slate immediately below (i. e., down stream,) a harder part, the softer part having been torn out faster than the rest. At the large rock island, east of the upper end of Island No. 5, the dip of the formation is 27° S. E.

There may be other dykes, not visible on account of their crossing the river under water entirely and entering the banks where they are hid by drift-wood or by standing trees and bushes. The dyke rock wears away faster than the formation that they cut.

The rapids below all the islands (on Sec. 15,) are over boulders. These rapids continue on between the islands to the foot of the fall which is on Sec 10, at the head of Island No. 3, the island itself cutting the fall into two parts, the greater part running to the east of the island. Six or eight rods below the foot of the fall begins the second island. Island No. 1 begins still further down stream and is cut by the section line between 10 and 15. This last is a very small island, having but three large pine trees, (though several small ones,) and seems to consist of boulders, and rises but two or three feet above the water. Island No. 2 rises twenty feet above the river, and is wholly covered with pine, with a few birches and cedars. A high drift-bluff, (227 feet,) causes the current here to turn rapidly toward the southwest, uniting with that which passes down the west side of the west island. Just above Island No. 6* is the wildest and most tumultuous portion

*The islands number 6 instead of 5. They are wrongly represented on the township plats. There are also a number of rock islands.

of the river, where it comes nearly along the strike of the slate. The descent here, in about a quarter of a mile, must be about forty feet. There is no regular fall, but a rushing and foaming torrent, dashing from side to side of the channel, cut and parted by the jagged protrusions of the highly dipping slate, which by its variations of hardness forms troughs that alternate with sharp and angular ridges. The dip of the slate, which sometimes rises in the middle of the river twelve or eighteen feet, and is very conspicuously disposed, varies from thirty to forty-eight degrees to the S. and the S. S. E. The former dip is to the S. and the latter to the S. S. E., the slaty cleavage being nearly perpendicular all the time. The grand bedding of the slate is in thicknesses of fifteen to twenty-four inches, but there is also a thinner bedding which is in layers of a few inches. Perhaps the heavier beds would show a finer bedding if favorably weathered.

The roar of this river here is greater than that of St. Anthony Falls, and it seems equal to that of Niagara. It is continued over so long a distance that the multitudinous dashing seems to make as much atmospheric commotion as the single plunge of a large stream at Niagara, and to be comparable to the roar of an extended beach-line. It can be heard for sveral miles, and is like the rumble of a heavy freight train on the railroad, for which it is apt to be mistaken at first, as it comes with the changing currents of wind or is echoed on the bluffs.

462. Fine-grained dyke-rock, from a dyke crossing the river at the mouth of the creek coming from the north on S. W. ¼ Sec. 10. It is above the foregoing rough and jagged portion of the river channel, visible only on the shore. It is less durable than the hardened slate. It is about thirty feet wide.

463. Rock similar to the last, from a dyke eight feet wide running N., about 15° E.. on N. E. ¼ of the S. E. ¼ Sec. 9, T. 48, 16, crossing the river.

464. From a dyke crossing the river a short distance above the last in the same direction, but thirty feet wide.

About thirty feet above the last appears to be another narrow dyke about six feet wide, but no certain pieces *in place* can be seen on the north bank. It shows as a gorge in the slate on the south bank. It is situated about ten rods below the small island in the river seen on the S. E. ¼ of Sec. 9, and about five rods above is another of the same uncertain character.

At the island on the S. E. ¼ of Sec. 9, T. 48, 16, the river is very rough as it separates and plunges among the rocks. The strike of the slate is nearly in the direction of the river. The island itself is made of a knob of hardened slate, with a few trees, and the beds that have a strike on each side of it stand up in the channel like inverted plows, and cause the water to twirl along on one side for a few rods or feet when it leaps over, or rises and falls over like the turf on the coulter, and runs into another trough from which it escapes in the same way. This takes place on each side of the island, but is particularly interesting and beautiful near the head of the island on the north side. Below the island, in the main channel, it then repeats this operation as it makes its way through other troughs. Generally the whole river is divided into several such troughs, but in a few places it is all embraced in one rapid chute about twenty-five feet in width; along the sides of which there is a boiling return current up stream, as the central current plunges and foams downward. I think there is noththing in the State that surpasses several of the scenes along this river. Norwood says the upper falls are indescribably beautiful, but I do not see how they can exceed these. Above this for half or three-quarters of a mile the river is more tame, but still constantly rapid, and impassable even for canoes, with frequent ridges of slate along shore and in the channel.

Just at the head of the island, and on the south shore, is an interesting irregularity in the layers of the slate. They first appear horrizontal, or rise gently from the water to horizontality. Then they bend downward, and even dip slightly northward, toward the river; then are suddenly deflected upward, but return to horizontality, when they again begin to dip into the river. This apparent change of dip is to a large extent only apparent. The beds still really dip south, the appearance being due to undulations of the strata, as viewed against the strike, combined with a jointage which breaks off so as to leave smooth planes sloping northward.

465. The slate formation from the railroad cut, N. W. ¼ S. W. ¼ Sec. 9, T. 48, 16. Tough gray, firm rock, hardly showing any tendency to slaty cleavage, finely arenaceous.

466. Siliceous slate, quartzyte, from the falls, center of Sec. 8, 48, 16.

Near the center of Sec. 8, is another fall of twenty-two feet, the river coming directly across the slate range from the N. W., the slate striking E. and W. The beds here dip 33½° toward the S. S. W., swinging round to the S S.E., and being then in a dip of 39 to 43°. This highest dip is seen at the narrows, where the water crosses the strike of the heavy beds. At these falls the rock appears less slaty than usual, though occasional similar layers of more siliceous rock occur mingled with the slates at points lower down the dalles. Here are heavy siliceous layers that require for the formation rather the designation of a quartzyte than a slate. Yet it is slaty, and breaks with the cleavage easier than against it. The rock here is also accompanied with deposits of white quartz, which is like that seen at Little Falls, and cracks up like that. The quartz deposits are seen to be rather veins than foliations, though they follow nearly the direction of the slaty cleavage.

The strike of the slate hills in sections 9 to 4, (48, 16,) is east, 10° north, and the dip is from 46½ to 60° toward the south, and the slaty cleavage runs almost east and west.

467. Rock of the dyke at Thomson bridge.

468. Rock adjoining the dyke at Thomson bridge.

The river at the railroad bridge over the St. Louis is running in the course of a dyke of igneous rock, about twenty-five feet wide. This being more jointed, and at the same time more easily rotted and disintegrated, has caused the gorge through which the river passes under the bridge. The walls on either side being of hardened quartzitic slate, are much more durable. This dyke is visible in the bluff facing the bridge down stream, and the rock is coarse and gray, but it is nearly hid by its own tumbling debris, while the slates stand up firm from sixty to seventy feet above the river. The dyke has a direction N. N. E., but is some crooked.

There is an island, also of hardened slate and quartzyte, in the river, visible from the bridge. This is due to the existence of another fracture in the formation which runs southwardly nearly to the bridge when it unites with the larger dyke; but just as it meets the larger dyke, the intervening slates were so finely, and so entirely metamorphosed, that the hardened mass has formed still another island (in very high water,) on which a pier of the foot-bridge rests. There is no evidence of this second smaller dyke except the gorge and the hardened slate walls. This gorge that forms, with the larger gorge, the two islands, continues northward a short distance in the north bank of the stream, but there is so much fallen drift and quartzyte in it that no igneous rock can be seen. The dip of the formation is 46½°. Half a mile northeast is a large dyke, sixty feet wide, which comes to the river between Thomson and the railroad bridge. It runs at an angle of forty-six degrees with the strike of the slate and quartzyte hills, but it is much more easily destroyed than they.

469. From near Miller's Mill, north of Thomson, a quarter of a mile. This is from a bed of harder, non-slaty, gray quartzyte, belonging to the formation. It weathers nearly white from feldspathic

ingredients, and from the abundant quartz, so as to look much like the trachytes of the western territories, but within is much darker. This bed is eleven feet thick, and in some places is conglomeritic. It has slaty layers on each side of it. It is massive, but parted by seams of white quartz, some of which are four inches thick. These seams wedge out lenticularly, and diagonally across the beds. The same sort of quartz veins are in other parts of the formation. Indeed, white quartz deposits are quite frequent in all kinds of seams or joints, or cleavage openings. The feldspar of this rock is triclinic and the ridge is *faulted*, the east side being moved south about twelve feet. (V. Nos. 310, and 418, and 505).

470. Slate, quarried for roofing, near Miller's Mill. This is black and of even, fine grain.

471. Slate like the last, from another old quarry.

472. White quartz, from a heavy deposit, forty rods above the railroad bridge, where the county road crosses the river, in the right bank. It is embraced in the slate, and its manner of occurrence is exposed on the side toward the river. It coincides in direction with the slaty cleavage. Near the top, the deposit is nearly ten feet thick, N. and S. but standing vertical it runs but little distance downward. It can be seen to run out, almost entirely, about twelve feet below the top, something like the roots of a tooth running into the jaw below the crown. It is not coincident with the bedding, nor with any system of joints, but stands perpendicular. It extends E. and W. conspicuously about ten rods. It is crossed by a narrow dyke, and it is faintly exhibited on the wall of a slate-ridge further west, and at a level twenty-five feet higher. Along the river channel where the water sweeps it, one large root runs below the water with a width of nearly two feet, and also another of six inches, but the greater part of it pinches out within ten feet of the top. At the place of deposit of this quartz there seems to have been an anticlinal locally formed in the slate formation, and the opening produced by the upheaved fracturing was afterward filled by quartz, some of it also collecting in other openings, the whole standing in nearly a vertical position. All about here is evidence of much displacement and crumpling, but rarely is there seen so evident a dip toward the north. The quartz is milky white, and mainly massive, but sometimes shows a splintery cleavage in the direction of the slates. It is jointed, and disintegrates by falling out in blocks which are distributed down the river, and once probably furnished stones for the quartz conglomerate (No 449.) As to minerals, this quartz contains galenite, pyrite and siderite.

473. Pyritiferous gray quartzyte (?); from the ridge along which the large quartz vein (472) is visible. The pyrite is scattered in perfect cubes, sometimes three-fourth inches across, and occasionally an inch, through the rock. The most of the cubes are about the size of peas. The rock is like No. 469, but finer, and has siderite as well as pyrite disseminated finely through the whole, the former becoming oxidized at the surface.

In some of the quartz veins which cross the strike diagonally, particularly in rock 469, and 473, which veins die out and are replaced by others a little further to the right or left, lenticularly, the white quartz has been intercrystalized with siderite, which on weathering changes to hæmatite, and then washes out if wholly free to the air, leaving a gashed appearance among the quartz crystals when exposed. On deep fracture, when not thus exposed, the siderite is preserved—and in other places can be seen passing into hæmatite.

474. Dyke rock, near the Northern Pacific Junction. This dyke is thirty feet wide. The average dip of the slate formation in S. W. ¼ Sec. 6, T. 48, 16, is 57 deg. to the S. 5 deg. E. West of dyke rock, No. 474, which is a little east of Paine's saw mill, are other dykes, parallel to 474, one being still nearer the mill, on the east side, and one west of the mill. They all run about N. 5 deg. E. (compass), with a slight variation a little east or west of that, and they all consist essentially of the same kind of rock—a greenish gray doleryte. In both respects they are like those seen crossing the river below Thomson.

475. Doleryte from the most westerly of the above mentioned dykes—one of the triclinic feldspars appears porphyritically in this, which is not common in the rock of these dykes.

Up Otter Creek, two or three miles west of the Junction, there is said to be a large exposure of rock, like that at the Junction. It seems then to continue on to Moose lake, where it is again seen thirty miles south of the Junction, and causes a rough and more elevated tract of country. On the road to Twin lakes, about a mile south of the Junction, there are three or four ridges of slate.

Northward from the Junction, along the Knife Falls railroad, a number of cuts in the rock display its character and position. Cut No. 1 is about three-fourths mile from the Junction and is in slate that dips south at about the usual angle. There is a little ridge further north, and on the west side, that has a much higher dip to the south—about seventy-five degrees. Cut No. 2, which is nearly a mile further north is in a hard, gray, massive quartzyte, which has joints running in various directions, and shows no dip, but in a small slate outcrop along its northern side there is sign of sedimentation dipping about 45 deg. S. (as usual.) The same dip can be seen in a parallel slate range on the west of the road nearly opposite this cut. This quartzyte range is high, long and conspicuous toward the east, but to the west it soon ceases. The slate range on the west also is short, and the surface settles down to a valley in which there is a stream, with a high timbered plateau on the north side.

Cut No. 3, about two miles north of the Junction, is near this high land, but the road bends east at the cut so as not to go directly toward it. (See No. 505.) North and west of the Junction are numerous slate ridges which are not struck by the railroad.

The river below Thomson is filled with rapids and falls all the way to "Bridge No. 5." There are four spots, in particular, where there is valuable water power:—first, near bridge No. 5, where the river in a short space is divided into various channels, by six islands that occur between its banks. Three of these islands are above the fall and three are below, but there is also a considerable fall above island No. 3, (numbering from below) extending to near the head of island No. 6. This whole fall is fifty-five feet. The existence of the islands and the widening of the river, as well as the extent through which the fall is carried before it reaches rather quiet water again, are favorable for the improvement of this power, and its utilization. But a short distance above the head of island No. 6, is the second fall, where the river is narrow, but has the rock formation of the country in conspicuous strike along each bank confining the water like artificial dykes, within troughs which run somewhat obliquely across the course of the river, and rising in knobs and rough islands (with constant dip toward the S. E.) in the midst of the river itself, sometimes eighteen or twenty feet. This condition of the river extends from near the head of island No. 6 to the dyke (No. 462 above), which is near the mouth of the creek that crosses the railroad on the N. W. ¼ of Sec. 10, and the fall here, which may be called cascade No. 2, amounts to sixty-five feet. There is then a gradual ascent of twenty-five feet among the rocks to the foot of the fall at island No. 7, and of twenty-five feet more in getting round the island itself, where the river is divided and beautified by the disposition of the slate ranges as already described under No. 464. This is cascade No. 3. Above this the river is more steady in descent for one-half mile, when there is a widening of the channel near the mouth of a little creek from the north, and a fall of about six feet over one of the harder beds that protrudes above the rest. This goes diagonally across the stream. There is then a similarity in the stream to and beyond the "retaining wall" of the railroad, a distance of nearly a mile, through which there is actually a steady ascent, amounting in the aggregate, from the head of cascade No 3 to the foot of the Thomson Fall, to seventy feet The Thomson Fall is regarded as beginning near the 133d mile-post of the railroad, (near the center of Sec. 8) and extending to the large island on Secs. 5 and 6. That part of it below the mouth of Otter creek which joins the river near the railroad bridge south of the railroad, extending a distance of nearly a mile, is thirty feet, and is caused by the strike of the rock going directly across the river, causing it in several places to be suddenly contracted in width to twenty or twenty-five feet, through which narrow passages the river rushes with some fall and a swift current. The most of the fall is near the foot of the distance stated, but there is an irregular rapid and rocky river all the way up to the railroad bridge that cannot consistently be subdivided, though it is more rocky at and near the mouth of Otter creek. That part above the mouth of Otter creek, extending to the foot of the large island, is thirty-five feet. The greater part of this is near the foot of the island, but the river is a rushing torrent, in a rough narrow gorge, sometimes split by islands, all the way from the first fall to the creek. The total fall from the brink of Knife Falls to the water at the foot of the lowest falls, N. E. ¼ Sec. 15, T. 48, 16, by ameroid, is five hundred feet, with an estimated descent of fifty feet more to the level of Lake Superior.

476. Rock from near the river, south bank, about a mile above Knife Falls. The same formation, with the same dip and outward aspect occurs along here. It extends at least to the village of Cloquet, the direction of the slates being E. 10 deg. S. inclined to the south at an angle of 75 deg. or 80 deg. Along the river are occasional low slate exposures. The islands are caused by low slate elevations.

477. From the same place as the last; coarser, similar to that near Miller's Mill. (No. 469)

These rocks are in some places cut by slaty cleavage. They are rather firm, but have a *grain* running in the line of the slaty cleavage (476), but in other places (477), it is not affected by cleavage, but is cut by joints running in all directions across it, so that there is a semblance to dip toward both the south and north. The slaty cleavage goes diagonally across the jointage systems. After a careful study the dip is made out satisfactorily to be toward the south. Between this place and the Indian Reservation, which is a mile above "Pose's," the country is covered with drift, and timbered heavily. At Pose's the bank is about one hundred feet high, and apparently consists wholly of drift. Usually there is a belt of swampy, clayey alluvium between the drift banks and the river, about six feet above the present stage of the water. The river is very quiet above Pose's to the little island known as *Pine Island*, three miles above, where there is a fall of about eight feet in a tumbling rapid, the most of the descent being below the island. No rock in place is visible at the island—only boulders, of many varieties, chiefly like the Rice Point rock at Duluth. The island has a covering of tall pine trees. The country is not hilly, only moderately undulating, with considerable good pine. The long, narrow island at Pose's is low and not rocky, or stony, even, but sandy and clayey. The lower islands are rocky.

478 Represents the last rock on the right bank of the St. Louis above Knife Falls. This is found on the south bank nearly opposite the foot of the island known as Homestead Island, very near the same place as No. 477 and 476, but further west This is firm, gray, crystalline, with translucent grains as if of quartz, also having rusty specks when weathered, as if from oxidized siderite or pyrite. This, under the microscope shows in thin sections that it is one of the arenaceous members of the formation. This is an important rock-horizon. It seems to run further east, and also to extend under the river, forming the islands—at least such layers occur in the strike of the islands, and also form the brink of Knife Falls. It varies a little, becoming more like the rock at Miller's Mill, (469), than 478 is.

This is supposed to be Norwood's "last rock," which he styled an igneous rock, or doleryte, (his No. 454), having a direction nearly north and south, crossing the river nearly at right angles. This rock has translucent grains (which may be his supposed nepheline) but it is certainly a part of the formation and strikes east and west.

479. Rock from the brink of Knife Falls, similar to No. 477, a gray quartzyte.

480 From the brink of Knife Falls, finely crystalline, with minute grains of quartz visible in thin section. There are places in the formation where there is a change in the crystalline character, a greater frequency of joints, a finer grain, a loss of cleavage, and other features that accompany the metamorphosing proximity of a dyke, but where no dyke-rock can be seen. This sample seems to be from such a place.

At Knife Falls the descent is fifteen feet altogether, and about six feet perpendicular.

On the island first above Knife Falls the dip is N. 25 deg , forming an angle with the slaty cleavage which dips S. about 85 deg., and frequent joints cut the strata. The rock at this point is slaty in the direction stated, but the real slatiness does not appear as soon as a coarser slaty lamination which, on the surfaces of opened jointage planes, is in layers about one and one-fourth inch thick and looks like a bedding of sedimentation dipping almost or quite parallel with the slaty cleavage.

481. Slate, from the point above described. The piece has the lines of supposed sedimentation crossing the slaty cleavage as noted.

Just below the point of the last observation, which is where a small channel crosses the island in time of high water, is a nice little fall of about five feet, in the channel on the north side of the island, the channel itself being about twenty feet across. This rock is firmer than the rest of the formation here, and consists of alternations of argillaceous slate with a slaty cleavage, and a gray quartzyte. This quartzyte has translucent grains like the rock of 479. Here the dip is plainly 48 deg. S. 3 deg. E., the alternating quartzyte and slaty layers being a sure indication of *what* the dip is. This observation negatives the last note in regard to dip, the structure there supposed to be dip (illustrated by No. 481), being due to a former slaty cleavage, or to a foliation, or to a striation produced by friction, or to what? The water crosses the strike at an angle of about 45 deg., where it passes over these beds. There are ten beds of argillaceous slate that do not (with one exception of a bed of about three feet) exceed eighteen inches in thickness, some being but about six inches, alternating with hard and gray quartzyte layers which have a little greater average thickness. These layers strike to the north of the main falls in the south channel, and appear on the east end of the island below the falls. The slate beds have a perpendicular slaty cleavage, but the quartzyte beds have no cleavage of that kind, but are variously jointed. The slaty cleavage gradually fades out in the quartzyte beds, firmly cementing them with the slaty beds. Many of the joints of the quartzyte pass through the slate beds, particularly those that run at right angles to the strike.

482. From the above slaty layers.

483. From the above quartzyte layers.

484. Samples showing intermediate characters.

At the real Knife Falls, which are on the N. W. ¼ of the S. W. ¼ Sec. 13, T. 49, 17, and face toward the north, the brink running exactly east and west, the dip is 48 deg. toward the south, and the rock consists of alternations of slaty layers with gray quartzyte, exactly as ast described for mumbers 482-3-4. But there are here two very prominent and persistent beds of the gray quartzyte, one of which forms the brink of the falls, while the other is forty feet below the falls, and lies immediately over the section of beds represented by Nos. 482-3-4, or is separated from them by an interval of twenty or twenty-five feet occupied by the same sorts of rocks as those. This lower quartzyte bed forms a spit of jointed rock that projects eastward just below the falls. Along the banks, both on the island at the west end of the falls, and on the main at the east end, immediately below the falls, there are heavy beds of gray quartzyte which seem to be as durable as the rock in the brink of the fall, but they have not resisted the water so well as those further down, just mentioned. They rise, however, higher in the banks, especially at the east end. The rock over which the water plunges has a basaltiform jointed structure about at right angles to the dip, but no characters of undoubted igneous rock can be seen, nor evidence of igneous action in the form of dyke-rock. Yet, just at the west end, even west of the little island that is in the fall and cuts it into two parts (the little island and the west channel make about one-third of the whole)—there near the west end of the little channel the rock is closely jointed in a direction N. and S. (or nearly) and hardened, becoming fine-grained, these characters also striking the spit running east from the main channel. This dyke-like appearance has a width of about four feet, and although it is in a low spot across the spit where sometimes water flows in a high stage of the river, yet it forms a little island in the rocky channel just in the brink of the falls.

485. Is from this fine-grained rock which has the manner of a dyke, though it does not show the mineral characters of the dykes that cross the formation. This belt runs N. and S. as above described. In thin section this rock proves to be granular and finely arenaceous, and hence a part of the country formation.

486. From the quartzyte spit below the falls.

487. Slaty alternations in the spit below Knife Falls.

488. Gray quartzyte, similar to 478 and 469.

This is from the north channel, from near the lower end of the third island (not counting the little island in the brink of the falls) and is north of that called Homestead Island. The rapids are twenty rods above its first exposure, which is much greater than on the south shore where 478 was obtained. These heavy, gray quartzyte beds, although they differ widely from the most of the formation, having a massive and jointed outward aspect, and thus resemble the dykes of true igneous rock, have not the composition of the dolerytes. Further, they run E. and W. instead of N. and S., and are interbedded with slaty layers. They could not be mistaken for dykes wherever their stratigraphic relations are visible. In this place no other rock can be seen. It extends along the shore about thirty rods (E. and W.) and does not vary. The main jointage system runs N. 3 deg. E. The rock gradually disappears among boulders some of which are very large, and yet seem to be like the same rock. They show, however, a little *grain*, or schistose structure, approaching that seen in some of the slaty beds of the formation.

489. Samples from one of these large boulders that seem to show a gradation toward the slaty beds. In rock 488 are veins of white quartz some being five inches thick.

About fifty rods further up the north channel is a cross-channel, between two islands, the water running north; opposite which, and immediately below, in the middle channel, are seen other rapids and much rock in place. The surveyors' plat of the river about Knife Falls is quite faulty. The islands are all represented as one, and the river seems to have but two channels instead of three. This rock shows a slaty cleavage running E. and W., which has a dip to the north, or is nearly perpendicular. It belongs to the formation of the country. South of this rock exposure, which forms a rapid place crossing the middle channel diagonally, is Homestead Island, or island No. 5. The rock is very like that forming the falls, but probably lies below it, as it is a little further north. In these rapids is a little rocky island, rising about eight or ten feet above the river, having three or four growing pines and cedars. These rapids are higher up the river than Norwood's "last rock."

490. An arenaceous, somewhat slaty, hard, gray rock, from the rapids in the middle channel, north of island No. 5, near Knife Falls.

491. From near the same place as No. 490, and related to it in position, in the same manner as the spit of hard rock below the falls is to the rock in the brink of the falls, *i. e.* in a conspicuous strike parallel and thirty or forty feet further north; a firm gray quartzyte.

492. Doleryte, from large boulders at the rapids at the head of island No. 4, scattered about as if from a large dyke in place near, but cannot be seen in place.

493. Gray quartzyte from boulders apparently derived from the rock in place near. The rock of the formation is in place at this point.

494. Rock from one of the firmer beds of the formation about one-half mile below Knife Falls, at the river bank.

Below Knife Falls in the first quarter of a mile there is a descent by rapids, of about twenty feet. The river then turns SE. The water is still rapid, and has a broken cascade over boulders at one-half mile, with a fall of about three feet. The rock is exposed constantly from

Knife Falls, the precipitous walls rising, at the cascade just mentioned, to the hight of twenty-five feet.

At a quarter of a mile below this is a fall of about seventeen feet in three hundred feet, there being no perpendicular fall. There is a division of the stream into four channels by the strike of five different persistent beds in the formation, the water running in the strike of the intervening beds, the hard beds forming islands in the falls. The width of the river at the brink is about two hundred and thirty feet, and a dyke of about two hundred feet crosses the river just at the head of the fall. This dyke is destroyed by the river faster than the rock itself, owing to its frequent jointage; and the most rapid descent of the water is over the hardened beds of the formation on the east side of the dyke.

495. Rock from the two hundred feet dyke at the falls above men, tioned. This dyke runs N. 5 deg. E., and is of a firm and fine grain though principally feldspathic. The dyke is finely jointed and easily shattered by the frost. The dip of the formation is S. 60 deg.

About one-fourth mile below this fall the river turns about south, so as to go directly against the strike of the rocks. The banks increase in height, the dip increases in degree, and at three-fourths of a mile further, there is a high rocky island (Fortress Island) from the foot of which a portage trail sets out to Knife Falls, on the west side of the river. The larger part of the stream passes on the left of the island, the descent being eight feet over large boulders. At this place the rock of the country is wholly slaty; and although a short distance above the island there is a gradual change in dip from 60 to 70 deg., and then to 90 deg., as the river exposes the beds, yet in viewing the island from the N. W. down stream, there is, besides the slaty cleavage, a coarse bedding or jointage system visible on the east side of the island that seems to dip about 45 deg. S. E. At a distance the island itself, in its perpendicular walls, covered with a red lichen, cut by joints that cause the slates to fall away in masses, looks like a basaltic island of igneous rock. But there is no igneous rock in it. It rises fifty or fifty-five feet above the water, and is covered by small pines, among which are many Norways. The actual bedding either coincides with the slaty cleavage or dips S. E. at about 45 deg. This is an interesting spot. The appearance of the island reminds one of basaltic Staffa, but of course its structure does not illustrate that. The banks of the river are not so high as the island, but on the east side the rock rises fully as high a short distance back. Below the island the valley is deep and has high, slaty walls, the water being steady for at least half a mile.

The portage trail which sets out here, going west, is that traveled by Norwood, and by the explorers and geologists that preceded him. Duluth was probably the first white man that passed over it. It leads to the Mississippi and to Vermilion lake. Douglass Houghton traveled it with Schoolcraft, and with Lewis Cass. It was the outlet for the immense fur-traffic of the Upper Mississippi region. The name "Knife Portage," by which it is usually known, is well applied, because where it starts, and for some distance, the slates are thin, perpendicular and sharp like knives.

496. The rock of the conntry, from the beds *in situ* at the head of the uppermost of the chain islands above Knife Falls, (same as 493.) This was got by Mr. Terry on making a re-examination of the rapids. He reported no dyke in place there.

497. From near the middle of the central channel, a short distance above the head of the uppermost chain island, gray quartzyte, (Terry.)

Mr. Terry also found similar rock in place near the head of Homestead Island, but a little on the north side, in the central channel, which seems to be really the "last rock" to be found in the St. Louis, until reaching its higher tributaries.

498. The rock of the country from one hundred and fifty yards above the fall where 495 was obtained. (Weitbrecht.)

499. Rock immediately overlying 498. (Weitbrecht.)

500. Slate from just below the falls described under No 494. (Weitbrecht)

501. Doleryte dyke-rock, center of Sec. 19, 49, 16, right bank of the river.

Below Fortress Island, where the first little rapid is seen, a dyke crosses the river about N. and S. It is forty or fifty feet wide, and is best exposed in the right bank some rods below the rapids. It is represented by No. 501 This dyke appears again thirty rods further down, and can be traced for half a mile along the right bank, to and beyond the floodwood. The direction of this dyke carries it across the railroad, near Paine's mile at N. P. Junction.

The river is then tolerably slow to and beyond the cluster of small islands just below the floodwood (hence named *Floodwood Islands.*) The floodwood now is a floating jam, in length about the same as the width of the river, six hundred feet, with a few alders on it, and is wholly above the islands, the lower end of it being about 1,200 feet above the islands. There is, however, a considerable other floodwood lodged about the islands and sunken between them.

The river is then slow and broad down to three other islands (not represented on the surveyors' charts) below which it again soon descends over rapids caused by boulders, about two feet. Here the river is broad and shallow. Then appear two islands represented in the S. W. ¼ Sec. 30. Between the larger of these and the right bank of the river is another rapid descent about three feet, over boulders. The rock of the country, however, closely underlies, as shown by an outcrop a few rods west of the right bank

At about a mile above "Cut No. 3" (N) on the grade of the Knife Falls railroad, mentioned under No 475, a creek crosses the new grade. At this place there is a cut in the rock on each side of the bridge. That on the south side is short and about four feet high, while that on the north side is about nine feet high, and extends about one hundred and twenty feet. In the south cut the slaty cleavage dips to the south, but is nearly perpendicular. In the north cut it is also nearly perpendicular but dips to the north. The sedimentary bedding is not discerned. There are belts of lumpy, white vesicular quartz, coincident with the slaty cleavage, which lenticular lumps are surrounded by a greenish slippery coating that often appears slickensided. These belts are sometimes wholly of quartz, and are continuous for some feet, and reach five or six inches in thickness. They seem to be the result of foliation coincident with the direction of the original sedimentation.

At the next cut which is about one-fourth mile further north, the depth is five feet, and the slaty cleavage dips slightly to the north. The cut extends about four and one-half rods. The rock is wholly slaty, and no sedimentary structure is observable unless it coincides with the slaty cleavage.

The road runs over water-worn boulders, with much corduroy, with no soil, nearly to the creek mentioned Then there is a filling, then occasional fills and shallow cuts in a little stony loam, with large boulders, the country being clothed with swampy varieties of trees.

Just beyond the point where the road strikes the drift bluffs of the river, another cut in slate-rock appears, the cleavage dipping north, as before, and including conformable layers or folia of white quartz, in varying quantities This is a firm slate, suitable for roofing, like much of it throughout the country. A short distance further are two small cuts in slate. In the northern one the slaty cleavage is different in different parts contiguous. The most of it dips toward the north, at an angle of about 45 deg., but in the midst of it are two belts that run from the top to the bottom of the cut, in which the dip is about 80 deg. toward the north. This cut is thirty feet long and six feet high. Further N. W. the road runs on a dirt fill on the slate ranges about a quarter of a mile. The rock can be seen and shows heavy bedding dipping toward the south about 45 deg., the slaty cleavage crossing the bedding with a dip of about the same amount in the opposite direction, the cleavage showing a *twist* out of the normal direction as it passes the joints from bed to bed. The whole aspect of these ridges is light-green.

At half a mile further is a long cut in greenish slates, perpendicular, or at the north end slightly dipping to the north, and at one-eighth mile further another small cut having the same features. Two more small ones appear before reaching a dyke which exposes a width at least of thirty feet. It appears on the N. E. side of the road and runs apparently, E. N. E. It is cut by the grade to the depth of about three feet, with a slate cut immediately south east of it. At half a mile further another dyke of similar character is seen near the Knife Falls. It is in place by the N. E. side of the grade, and was slightly cut in the grading. Its width and direction cannot easily be seen owing to the forest.

502. Gray doleryte, like No. 501, from the dyke last mentioned. One other cut in slate appears beyond the dyke about a quarter of a mile, but showing only on the north side, though frequent ranges of slate appear along the grade on both sides, rising six or ten feet.

503. Gray doleryte from the E. N. E. dyke before mentioned, apparently the same as No. 502.

504. Gray quartzyte holding slate-pebbles, as if conglomeritic, about two and one-half miles from the Junction on the grade of the railroad, situated between the "Cut No. 3" and the creek mentioned after No. 501. This quartzyte hardly has any cleavage, but shows a lamination in laminae about an inch thick, which indistinctly appear on shattering the rock by blasting. These have a high angle of dip toward the north, across the bedding, which dips south at about the same angle; and they are probably the product in this quartzyte of the same operation that caused the slaty cleavage in the slates. Although styled quartzyte, here as well as in other places, this rock also contains a large ingerdient of feldspar which in No. 504 is partly orthoclose. In others, the feldspar has been seen to be, at least in part, a striated feldspar. The slaty pebbles in this rock are rounded, and are often half an inch in diameter, and occasionally are two inches long.

They are fine-grained, and resemble the slippery coating that surrounds the quartz deposits mentioned under No. 501.

505. At the long "cut No. 3," mentioned under No. 475, there are several interesting features exhibited by the strata of the formation. This is nearly two miles north of the N. P. Junction.

1st. In the north end of the cut the slaty cleavage dips north about 80 deg., and in the south end it is nearly perpendicular.

2nd. In the southern portion of the cut is a change in the formation from slate to a gray arenaceous rock like Nos. 469, 478, 488, 491, 493, 497 and 504, though it is not conglomeritic like the last; and the slaty cleavage on both sides of this rock is conformable with its surfaces. This rock is represented by No. 505. It has somewhat the outward appearance of a dyke of igneous rock crossing the road in a zigzag course E 5 deg N. It weathers nearly white and has a width of twenty-seven paces.

3rd. This rock, (505) has no slaty cleavage, but a coarse jointing. The slate beds on the north side dip N. and on the south side they are about perpendicular.

4th. On the east of the road, one-fourth mile distant, is a high hill of rock of this kind, and near the north end, on the west side, the ridges show a twisting in their strike, or a quaquaversal throw, so that the E. and W. slaty cleavage crosses them diagonally, the ridges bearing S. E. and N. W.

5th. Hence the slaty cleavage came after the tilting of the formation, and keeps its E. and W. course whatever the direction or amount of the dip.

6th. The hill of this rock, above mentioned, is east of the road less than one-fourth mile. It is an isolated knob rising about twenty-five feet above all the other ridges. It is about circular and five rods over, with a broad rounded top. It seems to be a sudden augmentation of No. 505 among the slates, and its connection with No. 505 in cut No. 3, can be traced connectedly. The course of 505 is about toward the rapid in the St. Louis, three quarters of a mile above the Big Island in the river near Thomson.

506. Large sample of slate, showing the slaty cleavage crossing the sedimentation, from one mile north of N. P. Junction, Knife Falls railroad.

Along the east side of the Big Island near Thomson, the ranges cross the river, causing rapids, and a descent of about ten feet in twenty rods, the most of it being in the lower ten rods. The river here runs against the strike, and the channel is narrowed as below

Thomson suddenly, to about thirty feet. The rock dips 45 deg. N. and stands up conspicuously along both sides of the channel, the slaty cleavage dipping 45 deg. to the south. There is then comparatively still water to about the middle of Sec. 31, (south of it a little), where the rock again causes rapids and a descent of six or eight feet.

507. Gray, slaty quartzyte, "just across the north channel at the head of the second rapids, on Homestead Island." (Terry.)

508. At the extreme upper end of Homestead Island, at the very point, higher up than any rock along there before mentioned; a gray quartzyte, with visible grains of quartz. (Terry.)

509. Some rods east of the head of Homestead Island, on the north side, about one hundred rods west of the head of the rapids that there run across to the other islands; a gray quartzyte. (Terry.)

510. Slate from the very foot of Homestead Island, below the rapids last mentioned. (Terry.)

The Chain islands, here so designated, are often known as Green Islands, from the man who preempted them. The "Grand Rapids," of the St. Louis begin one-half mile above Pine Island, and continue five or six miles. The water then is comparatively quiet to the mouth of the Cloquet. Just below its mouth is a large rapid. (Mallmann.)

Downward section of the red sand rock and shales at Fond du Lac.[*]

1. (443.) Red sand rock, quarried at Fond du Lac. This begins above the level of the railroad grade and extends downward through a thickness of (estimated).................................... 50 ft.
2. Dark red shale.. 18 ft.
3. Shaly sand rock, less firm and siliceous than No. 1, (changes gradually to the next).............................. 12 ft.
4. Red shale, with some sandy beds...................... 30 ft.

Ascending the river, here it turns south, and as the dip is to the S. or S. E. the sand rock No. 1 is brought again into sight in the banks of the river at the extremity of the point, and in the opposite bank of the river. This is about one-half mile west of the state line. No. 4 again occupies the low river bank (north bank) above the point, after it turns west again, for ten or fifteen rods. It has some beds of light color, a few inches thick, such lighter colored beds being coarser. After a short distance of no visible rock, the underlying beds appear, viz.:

	Ft.	In.
5. Fine conglomerate light..........................		6
6. Red fissile shale..................................		8

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[*] Also see Nos. 443 to 449.

7.	Light colored coarse sandrock, or fine conglomerate..		8
8.	Red fissile shale..........................	4	6
9.	Fine conglomerate (light)..........................		5
10.	Fissile red shale..........................	3	
11.	Fine conglomerate (light)..........................	3	
12.	Fissile shale, with green spots, some beds ripple-marked..........................	14	
13.	Fine conglomerate..........................		8
14.	Fissile shale..........................		3
15.	Fine conglomerate..........................	2	
16.	Fissile shale..........................		3
17.	Fine conglomerate..........................		4
18.	Fissile shale..........................		4
19.	Fine conglomerate..........................	1	
20.	Fissile shale..........................	3	6
21.	Fine conglomerate..........................	1	6
22.	Shale and shaly sandrock, with layers of light green, seen..........................	14	

The bluff here is about twenty-two feet, (of exposed rock) for about thirty-five rods, below the creek that comes under "Bridge No. 1," and for about ten rods above, the opposite bank having no exposure.

		Ft.	In.
23.	Light red sandstone..........................	3	
24	Fine red conglomerate..........................	4	6
25.	Shaly sandrock, red..........................	10	
26.	Fine red conglomerate..........................	3	6
27.	Red shale and shaly sandstone; makes a dark band...	9	
28.	Lighter colored sandrock..........................	8	
29.	Green shale..........................		6
30.	Red shale and shaly sandrock..........................	9	
31.	Fine conglomerate, with some thin layers of shale....	4	
32.	Sandrock, mottled and striped with cross-sedimentation..........................	5	

The mouth of the creek coming under Bridge No. 1, is on this sandrock.

33.	Fine conglomerate; the middle of this has pebbles an inch across, but is finer above and below........	7	
34.	Shaly sandrock, with specular specks, as if micaceous or hæmatitic. This extends but few feet, and pinches out into fine conglomerate..............		8
35.	Fine conglomerate..........................		10

36.	Fine shale		4
37.	Fine conglomerate	2	
38.	Shale		2
39.	Fine conglomerate, light-colored		6
40.	Sandstone, light-colored and red, with horizontal bedding; pinches out in fine conglomerate in twenty feet	1	2
41.	Fine red conglomerate with false bedding, passing below into a coarse, light-colored sandrock with false bedding	3	6
42.	Red, crumbling conglomerate, coarser below, with some pebbles of two inches	7	
43.	Shale, with green spots and some conglomerate	1	6
44.	Firmer, lighter colored conglomerate, inclosing beds of shaly sandrock which have cross-sedimentation.	3	
45.	Fine green and red shale		7
46.	Coarse shale	1	
47.	Fine red shale. Of this, but one foot can be seen at first; but as No. 44 strikes across the river forming a little rapid, and shows its place of beginning on the right bank, the section is easily continued on that bank. The stream here runs nearly at right angles to the strike, and a bluff rises about eighteen feet on the right bank consisting of Nos. 41, 42 and 43, or beds like them. Large blocks of No. 44 lie along the river, in the talus on the left bank. In these blocks are mainly pebbles of white quartz; then jasperoid and colored quartzytes; then arenaceous quartzyte of a red or pink color; then pieces of a greenish slate, and rock like the Thomson slate rock. The pebbles are generally under an inch in size, and the surrounding material is also a fine conglomerate	15	
48.	Coarse, firm, light-colored pyritiferous conglomerate, sloping gradually into the water. This includes lenticular spots of shaly sandrock, and of red conglomerate. For some rods the upper surface of this conglomerate forms the low shore and is washed by high water, dipping into the river at an angle of 8 deg. It then stops abruptly by a fault, and the shore is occupied by a red and spot-		

ted green shale like 47, of which the dip is more to the south. Where the conglomerate is broken off it is highly pyritiferous, and cemented into a compact rock, and at the very fracture the whole is changed and vitrified, making a firm greenish quartzyte. In the bluffs on the opposite shore, (i. e. on the right bank,) may be seen four separate faults crossing the red shale andsandstone beds (apparently 41, 42 and 43,) from the top to the bottom. This is just opposite the point of faulting of the conglomerate on the left bank. After the abrupt disappearance of this conglomerate the left bank in ascending the stream is found to be occupied by a low exposure of layers of green and red shale belonging to some higher portion of the section, while the right bank opposite is a bluff with an average exposure of ten feet of rock, consisting of red shale and shaly rock, with varying dip. All at once the coarse conglomerate rises again, but not so suddenly as it disappeared, and forms the shore to the place where the slate formation is found underlying it unconformably. Where the conglomerate reappears it seems not to be faulted, but bent and somewhat broken upward, the shale-beds above also being somewhat bent and compressed, though maintaining a green color where in contact with the conglomerate. The change of level is about two feet, and it is expressed on the opposite shore in undulations in the strata. It is about forty rods above this point that the slates first appear under the conglomerate, estimated.................................. 50 ft.

49. Coarser conglomerate, containing about the same materials as the last, except the layers of sandrock. Dips S. E. or S. S. E. 7-10 deg. The white quartz pebbles are sometimes six or more inches in diameter. Some are of gray, or even a black jaspery quartzyte, and some are pieces of the underlying slate, showing the slate must have hardened as slate prior to the deposit of the conglomerate. On the oth-

er hand it is to be noticed that a roughly slaty manner of disintegration passes upward into the conglomerate from the slates where the weather has acted on the two at that horizon, the pebbles and cement falling off in slabs or lumps that are elongated in the direction of the slatiness of the slates and parallel with them, as if the cause that operated to produce the slatiness had taken effect since the deposition of the conglomerate, and had resulted in a similar structure in the overlying rock. In this conglomerate are pebbles of gray and black jaspery quartzyte which much resemble the great quartzyte of the boundary line, seen at Pigeon Point, and really can be referred to that formation. This seems to imply that that formation, which, with its jasper beds overlies the slates, should come in between the conglomerate and the slates, but for some reason is wanting here. The conglomerate at Grand Portage Bay may have that relation. (V. No. 254.) In some places a layer of green shale lies between the conglomerate and the slates. It is a foot thick. The coarse pebbly quartzose conglomerate has an estimated thickness of.. 100 ft.

The overlying finer conglomerate is often red.

Total observed thickness of the Potsdam at Fond du Lac is therefore............................ 412 ft. 4 in.

By making a general trigonometrical calculation, with an average dip of 6 deg., and a hypothenuse one and one-half miles long, from Chamber's quarry to about half way between bridge No. 1 and No. 2, where the conglomerate begins, the thickness of the red sandrock and shale is found to be 883 feet. To this must be added the coarse conglomerate.

From Duluth to Silver Islet and Return.

511. At a point in the bed of Miller's Creek, just above the highway bridge near the ¼ section line of 32 T. 50, 14, 424 feet above Lake Superior, this sample was obtained. The rock, which is gabbro associated with fine red syenite, extends indefinitely up stream. It is jointed conspicuously N. W. and S. E. like a dyke. It is in some

places speckled finely with red feldspar, and in others it is crossed by veins of red feldspar, some being an inch in width and others very thin, somewhat resembling the rock at the old quarry of Maj. Newson at Duluth. Below the bridge is a rapid descent over rock of the same sort, in which the formation shows a coarse bedded structure, and dips E. at an angle of about 25 degrees. The left bank of the creek rises perpendicular about 23 feet, and the right slopes up gradually with the dip of the rock. The summit of the gap through the hill range is 607 feet above lake Superior. This is about a mile beyond the crossing of Miller's creek.

512. N. E. ¼ Sec. 25, T. 50, 15. Along the Herman town road occasional exposures are seen, rising above the rolling surface of gravelly red clay, of which this is a sample. It is a heavy, gray trappean rock with so much magnetite as to disturb the needle. Land of Peter Benson.

513. Rice Point gabbro, from a cropping on the N. W. ¼ N. E. ¼ Sec 27, T. 50, 15.

514. S. W. ¼ Sec. 22, T. 50, 15, (near the center of the quarter), land of John Mallmann. Here is an unusually magnetited bed of the rock of the country. It can be traced along about 200 feet, having a width of about 20 feet, as exposed, in low ground, bearing E. 10° N. It lies 5 rods to the north of another series of croppings of rock like No. 513. On the opposite side of a little creek, north of this number, is also a line of outcrop of rock like 513. No. 514 controls the needle entirely. It is dark, but specked with porphyritic crystals of labradorite. The center of Sec. 30, T. 50, 14, is the highest point in the hill-range, on the Herman town road, and is 747 feet above lake Superior.

Reviewing the rocks between Minnesota Point and Kinichigaquag creek one is compelled to the conclusion that they are mainly sedimentary; *i. e.*, in the sense that they were deposited in water and in that way received their stratified arrangement. They dip S. E. They also exhibit some of the characters of igneous rocks, viz.: their amygdaloidal structure, their color, their hardness, and an occasional wrinkled surface, that was formed by the fluid condition of the rock when flowing down an incline. The last characteristic particularly seems to prove that some of the beds were molten. On the other hand they show nearly all the characters of sedementation—parallel lamination, dipping in a constant, or nearly constant, direction, cross-stratification, variation of texture and color as well as mineral composition in the direction across the bedding. Whether they lie, stratgiraphic ally, above or below the sandrock at Fond du Lac is solely a matter of speculation, so far as the evidence here has any bearing.

There is a red sectile rock (Nos. 18, 19 and 30) that shows conspicuously along here, between Duluth and Chester Creek, which may have been driven by semi-fusion, and by igneous injection into the openings, &c., of the lower part of the igneous rock that forms Rice Point, and the hills back of Duluth. This is on the supposition that the Rice Point rock lies over the Chester Creek bed, and is in keeping with the fact that a red feldspathic rock occurs in patches in Duluth, and is in seams in the Rice Point rock at Newson's quarry. In that case the point of outflow of igneous rock was further to the northwest, and the lava ran over the broken beds toward the S. E. Before the full force of the igneous overflow is met in passing N. E. along the coast, the sedimentary beds occupy the coast except where, by dykes, or by interbedding, or by local outflows, the trap rock is found in its place. This indicates that during the period of deposition the igneous disturbances were going on, and that the semi-igneous nature of the beds may be due partly to the proximity of the igneous vents which would not only give an occasional flow of truly igneous rock, but would furnish a sediment quite different from an ordinary oceanic deposit. Ordinarily the sedimentary beds have a reddish color, but in the neighborhood of Chester Creek, and in Duluth some of them are greenish. The trap-rock seems to take a bluish green color along the shore. Occasionally a hardening of the sedimentary beds is produced so as to form a rounded point or promontory, or a sharp rocky point. Without such hardening the sedimentary beds usually are less durable than the trap-rock. In some cases, still, there is so close a mingling of igneous and sedimentary characters it is wholly impossible to decide, on the spot, whether a rock be igneous or not.

515. At Sucker river (V. No. 89). A fine-grained igneous rock, which crosses the mouth of the river. But it runs N. E. instead of N. 5° E.

516. Forms the bed of the stream, and appears like a bed of lava, being not jointed regularly, but smooth and massive, with pot-holes. This disintegrates into globules and rots to a great depth before falling away. It is heavy, dark green, and almost black when wet. In the stream are many pieces of prehnite-amygdaloid with a little native copper. These must have come down the stream from a belt which runs from French river southwesterly, back of Crystal Bay, and N. E. to Sucker river.

East of Stony Point, which is the east point of Sucker bay, the rock forming the immediate shore is an overflow of heavy dark trap which extends to Knife river; but within the bay east of Knife river are amygdaloids and purgatories for a mile and a half. Thin clay hides the rock, except occasionally, to the west point of Agate bay where begins about the same series of amygdaloids and non-amygdaloids as seen near Knife river, extending round the point and along the west side of Agate bay. Thus the rock from Stony Point to Agate Bay is all igneous. There is a similar alternation on the west side of Burlington Bay. (V. Nos. 94–102.)

517. Fine-grained trap, bedded, from the foot of the high bluff at the north of Gooseberry river. (V. 108.)

518. Trap-rock, top of the low bluff at the south end of the beach at Gooseberry river, containing amygdules of chalcedony. Furnishes some of the pebbles, and all of the agates of the Gooseberry beach. This rock slopes into the water, and where it is constantly under the action of the waves, and partly decayed, it is reddish, like the pebbles, but the pebbles mostly come from another bluff.

519. Agates, taken from the rock at Gooseberry river. At Gooseberry river is a high beach (25 ft.) of red gravel, extending from rock to rock (from 517 to 518), facing east, thrown up by the counter action of the current of the river against the easterly storms on the lake, which not only sweep the pebbles along the beach toward the west, but prevail with great violence in the spring and fall months. It is 300 paces long. In the red gravel of the beach are numerous chalcedonic agates, derived from the rock of the place. The bluff at the north end of the beach is about 75 feet high, and at the south end it is about 10 feet. In each case the rock slopes E. S. E. down to the lake, and below the water. They were once probably connected, forming a continuous sloping surface of trap-rock. The lower part of the bluff at the north end is bedded, and more jointed, but is fine-grained and firm. It is probably igneous, and seems to contain considerable chrysolite. The upper part contains chalcedonic amygdules, and is trappean. It decomposes in globuliferous parts, and is spotted by them before decay, the general color being a dark or bluish green. The whole bluff is trap and 75 feet thick. The beach is red with a few blue pebbles. The red gravel is finely amygdaloidal, and cannot come from the trap. The globuliferous decay is not noticeable in rock at the east of the bluff, near the water, perhaps because the erosion wears it away too fast.

The lower part of the high bluff at Gooseberry river, a short distance east of the river, is amygdaloidal with laumontite, and crumbles out faster than the overlying trap, causing the fall of large blocks from the top of the bluff.

The beds 517 and 518 occupy the coast exclusively (except one or two amygdaloidal beds,) with short intervals of red pebbly beach, to about one mile from Splitrock river, when a bluff rises from the water in a bay (No 110) and continues eastwardly. This bluff is the source of the red pebbles at Gooseberry beach. It is finely porphyritic with red feldspar, and seems also to have fine grains of calcite and quartz, as well as a few green amygdules. These, weathering out, produce a pitted water-worn exterior. The rock does not crumble, but goes to pieces in a multitude of small fragments which strew the beach and make the gravel. It greatly resembles the rock at Crystal bay (No. 78) and also the Palisade rock (Nos. 138 and 139), but is less firm than the latter. Its disintegration in angular bits in the bluff, by frequent divisional planes (not properly a jointage) is exactly like the Crystal Bay rock, but here it contains no large geodes of calcite, as there. It has the appearance somewhat of underlying the trap of Gooseberry river, but it actually overlies it.

520. Sample of the above rock, one mile west of Splitrock river.

520. A.—Sample of calcite-laumontite, from a vein in No. 520.

The westerly end of this bluff seems to show that it rises from under the rocks 517 and 518 with a strong dip toward the W. S. W. perhaps 40 degrees, but this westerly dip is not due to sedimentation tilted in that direction, but to a transverse jointage. It is so intimately jointed and angular that the original bedding, by which a deviation of dip is to be ascertained, is nearly obliterated.

521. Is an irregular thrust-up rock, appearing in the beach near the west end of 520. Its bedding is distorted. It almost appears conglomeritic, but the lumps and nodules that appear in it are due rather to crystalline aggregations, imperfectly formed. Some of its firm parts appear like the metamorphosed greenish quartzyte seen under the conglomerate near bridge No. 5 above Fond du Lac (V. after No. 510, in the *Section of the Red Sandrock at Fond du Lac* (Sub.-No. 48). But in the midst of this green are thin red (vitreous?) laminations that resemble in form, but not in color, the translucent streamed(?) interlaminations seen in No. 140. It is essentially a part of No. 520, but modified by some closely contiguous igneous agent. (V. 816).

Toward the east the bluff (520) shows horizontal bedding one, two and three inches thick, and the red rock passes inland among cedars, balsams and pines. At nearly the same point a lower trap-rock appears in the beach, being the same as that forming the little island opposite the bluff, 520, since it can be traced connectedly from the little island—by the shallow water—directly to the the foot of the red bluff. This lower trap holds a gray amygdaloid about 8 feet thick, and its lower beds run in the gravel beach, nearly to the Splitrock river, the chief exposure being just at the point, and 15 feet high (V. Nos. 111 A & 111 B). The red pebbles at once disappear, except that a few, mixed with the gray, are seen even at the mouth of the Splitrock, brought down the river and distributed westwardly. Where this lower trap appears in the little island it is agatiferous, at least has concretionary masses of quartz a foot or more in diameter, as well as other dark masses, 384 ft. in diameter. The geodic quartz cavities have few amethystine crystals. In this respect this trap bed seems to resemble the trap at the top of the bluffs at Gooseberry, instead of being another layer. In some places this is finely amygdaloidal, on the island, but generally heavy, compact, angular, and dark colored. These parts are irregularly mixed, and sometimes surround each other, as if in concretions, or as if one had been mixed in the other as a matrix.

Splitrock Point exhibits a novel and interesting geology. While the large feldspar mass seems to be in place, and to have furnished the smaller pieces embraced in basaltic trap toward the S. E. and E. it is highly probable that it is itself a transported mass. The oblique basaltiform structure of the trap shows it was molten and the feldspar was not. The feldspar is not basaltic, only coarsely jointed. This feldspar rock has a close resemblance to the Rice Point granite. It seems also to be older than the sandstone and conglomerate beds along here, and not to pass into the trap layers that are so conspicuous along the shore. There is a constant dip toward the S. W. in passing along here, and finally the feldspar rock seems to come to view as if lower than all. There is trap near the water, at the base on the east side. This continues, and shows oblique basaltic structure which slopes N. E. and a bedding that dips S. W. (V. 112 and 113.)

Immediately across a little bay east of Splitrock Point, and on the north side of the bay, at the foot of a high bluff (175 ft.) of Feldspar rock which stands a little inland, is an exposure of a dark-red, frequently jointed, rock. It is somewhat amygdaloidal, and especially near the top of the bluff, and seems to be a slightly altered condition of No. 520. It shows only a short distance (6 rods) and dips N. N. E. about 30°. It is darker red than No. 520 on fresh fracture, but the joints that give color to the bluff are lined with lighter red. It is probably also one of the shale beds of the formation, if not the lowest.

It is cut square off, and is immediately replaced by the obliquely basaltic trap (No. 524) which embraces masses of feldspar rock. Here the trap rises 50–75 feet above the talus of fallen pieces as the bluff extends east.

522. From the foregoing reddish-brown rock near its point of contact with the basaltic trap, near the top of the bluff, in the bay first north of Splitrock point. It here becomes darker, denser and firmer, and also amygdaloidal, bringing it to the characters of the rock that forms Two Harbors, the next point east. This seems to be another condition of 520, or beds like No. 520. In thin-sections it seems to be identical with the Two Harbor rock.

523. From the base of the same bluff. Similar rock, but more red. The Two Harbor rock is No. 117.

Just beyond Two Harbor Bay, (east) the relative superposition of Nos. 522 and 523, and their relation to the Two Harbor rock as well as to the Feldspar rock, can be seen. A feldspar bluff rises perpendicularly from the water about 125 feet. On the west of this bluff and in immediate contact with it, rises a basaltic trap bluff which is composed of the rocks.

524. Is a basaltic dark trap, 75 feet thick—underlain by 522, 523 and the Two Harbor rock, in the order named—the Two Harbor rock rising but little above the water. (V. No. 112).

Numbers 522 and 523 here show a sedimentary structure very evident, but it is in patches, and alternates irregularly with patches of laumontitic amygdaloid.

525. Sometimes a sandy sedimentary rock is in immediate contact with and surrounds patches of the amygdaloid. In the sandrock, which is of a light color, blotched with red, are impressions of fucoids. (V. No. 817).

On the east of this high Feldspar point there is a huge pudding stone of trap and feldspar for a short distance, and then under it a short exposure of No. 520 just as the bay begins. This last rises and runs inland, and the Two Harbor rock makes the immediate shore through the bay to the third high point, which is composed of a sudden upheaval of both the 520 and the Two Harbor rocks, the latter being basaltic and making the high point. (V. 119).

526. The knob of rock at the west side of Beaver Bay is of a crystalline red rock, feldspathic and firm. The green trap embracing the feldspar masses abuts suddenly upon it, from the west, and so ceases. This probably is the same rock as 119, and 520.

527. Sample showing the union and welding of the feldspar mas

at Beaver Bay.with coarse trap inclosing it. It is not thus welded generally, so far as visible, but is loosened fron the trap.

528. Slaty, gray quartzyte, at the mouth of Beaver Bay creek. These samples are from the rock at the very mouth of the creek. It also runs back from the creek toward the west. Its abrupt and isolated outcrops will not permit any satisfactory identification of its horizon or its place in the shore series. (V. 127 and after 816).

529. (No. 1 to No. 6). Series of changes from trap rock to soil, Beaver Bay:

(1). Unchanged traprock, heavy and coarsely crystalline.
(2). Iron-shot and jointed trap-rock.
(3). Showing incipient decay.
(4). Crumbled trap-rock.
(5). Gravelly, earthy soil.
(6). Loam, soil and turf.

These are produced by the rotting of the trap-rock of the country, on the promontory where no other ingredient contributes to the soil.

530. Finer, dark trap, of the same general character as that which covers the country, but finer grained, magnetited, and perpendicularly basaltic, having a coarser grain in a dyke-like belt (2½ feet wide) running E. and W. This rock contains patches of red rock like No. 526 and within two rods, after a short interval not exposed, the rock No. 526 is seen in full force forming a bush-covered bank. The patches are as fragments or boulders, generally, but some patches do not appear like transported masses, but like dykes and veins. This is from the bay one-half mile west of the knob which is represented by 526.

531. Sample of the above narrow dyke-like belt, which is similar to No. 529, but seems to contain free quartz. The general dip of the rock 528 is to the east, as seen in passing inland, and along the road to town, so as to throw it, if continued, under the rock of the promontory.

532. Reddish, and sometimes greenish, trap-like rock, surrounding, or embracing pieces of the feldspar at Beaver Bay. This rock is similar to rock No. 526, at least in some of its parts. The feldspar masses have the appearance of having been carried in this rock, or to have been *in situ* when it was deposited as a sedimentary rock, and subsequently to have suffered the metamorphosing forces with it. (V. No. 816.)

533. Rock of the great palisades. (V. 139.)

At the point that encloses the beach of gravel at Little Marais, a red pebbly conglomerate is seen running under the basaltic trap (No.

160) that makes the point, but separated from it by about two feet of amygdaloid that bears white thomsonites. This conglomerate must be that seen a short distance below Baptism river (155). The Sawthuth Hills, a spur of which runs out at Baptism Pt., run here still further back from shore, so as to bring the lower beds of any rock involved in them, at the shore along Little Marais. This conglomerate is also probably the real rock underlying the long stony beach extending for a mile or more above the point that is on the west of Little Marais.

East of Little Marais, for a couple of miles, the coast is formed by the Little Marais trap, sloping rather steeply into the water. The underlying amygdaloid is exposed also. The conglomerate is sometimes converted into an amygdaloid, and its true original character is hardly discernable. There are, however, red blotches that indicate the original pebbly character of the whole.

These three parts:—

1. Basltic trap-rock.
2. Reddish amygdaloid.
3. Reddish conglomerate.

make a jagged coast, with sharp points and little bays, almost continuously rocky, to about a mile and a half or two miles east of Manitou river. They sometimes rise 40 feet perpendicularly from the water. There is a little harbor from S. W. winds about one mile east of Manitou river. There seems to have been one grand igneous overflow here, just after the conglomerate, which is about 70 feet thick. The conglomerate itself is amygdaloidal, and the whole is red. The pebbles also are amygdaloidal, and generally less than an inch in diameter, but some are 8 or 9 inches across. The amygdules are calcite, laumontite, and white thomsonite. Sometimes beds of conglomerate and amygdaloid not conglomeratic alternate two or three times, and sometimes they blend or cross each other, showing no widespread variation in the nature of the conditions under which the whole was deposited, but rather indicating that at other points the whole would be found to be a conglomerate.

534. Samples of red amygdaloidal conglomerate from 1 mile east of Manitou river. The same is seen at the mouth of Manitou river. At this point the strike of the trap passes some distance inland, forming a spur of hills that rise several hundred feet back of Pork Bay, with low tillable land along the shore.

535. (V. No. 193).

Thomsonite amygdaloid, from Terrace point, near Good Harbor *Bay*.

535. A.—Thomsonites, picked from the rock at Terrace Point.

535. B.—Thomsonites, &c., gathered from the beach at Terrace Pt. These pink thomsonites seem to have some of the characters of edingtonites, as in a weak H. Cl. solution they give a precipitate with sulphuric acid, which must be sulphate of baryta.

536. Samples of the basalt rock, at Grand Marais, many of the small pieces being sections of the smaller basaltic columns.

537. Bedded trap, from the west side of the point on S. W. ¼ Sec. 10, T. 61, 2, E. Similar to the trap at Grand Marais. (V. 211.)

538. Red rock, similar to the rock of the Great Palisades. This is the first rock east of Cow's Tongue Pt. in the bay. (V. 212.)

The rock of Fish Hook Point (No. 213) lies as an overflow, and is visible under the water toward the west for some distance, cut also by dykes, some of which appear on the shore.

539. Brown trap, with chlorite amygdules; similar to, if not the same as the Fish Hook Pt. rock, from a short distance west of the mouth of the Brulé river, near the river. (V. 220.) There is no rock at the mouth of the Brulé, but a remarkable high beach, which shuts in a lagoon on the landward side. The pebbles composing it are of mixed character, some are red, from the red rock of the country (538), and some are blue or green, from the fine basalt or dykes, with amygdaloid and porphyry pebbles.

540. Coarse doleritic trap; a mile and a half east of the Brulé river. This rock sets in immediately east of the Brulé (No. 221), and forms the coast nearly continuously. At the point where this sample is got there is a little eastward facing bay, and a gravelly beach, but the same kind of rock is found on the east of the bay. This rock is light gray under the friction of the beach-gravel, but is black with rough lichens when washed only by the water. This rock seems to lie under the red rock which disappeared under the lake on the west of the Brulé. It continues to Horseshoe bay, on the west side of which is a basaltic bluff like that on the west side of Sickle bay. In the interval between these two bays the rock is occasionally interrupted by short re-entrant bends in the coast, where stony beaches largely made of the trap of the country are found, but the most of the distance is rocky and generally less than ten feet in height. The bluff on the west side of Horseshoe bay is 60 or more feet high (V. No. 228).

There is a high range of hills that run across the head of Double bay, rising apparently from the coast in spurs, one from the west side of Sickle bay, and one from the west side of Horseshoe bay. This range is short, as it can be seen for only three or four miles. The top is of the rock No. 540, which probably lies under the red rock and over the Grand Portage slates and quartzyte. It seems to be the same as the basaltic rock that caps the hills of slate and quartzyte along the international boundary. The beach at Cannonball bay is of rounded stones of all sorts, but a little sandy patch is covered with iron sand, derived from No. 540 inland. The rock 540 is seen to run below the E. Palisades, or the "red rock," so-called, judging by the general topography and the prevailing trend of all the beds. As the trend of 540 passes inland, a range of hills rises several hundred feet, extending N. E., the "red rock" occupying the low land between them and the lake, cut by heavy dykes of basaltic green trap. The Eastern Palisades have a short exposure just west of the mouth of Red Rock creek, rising gradually up from the water to about 25 feet, and then breaking off square and suddenly on the land side. They extend perhaps 150 feet along the coast in this manner, but are wider in a low exposure half covered with beach pebbles toward the west, at least 50 feet. The dip here is toward the southeast, but at Red Point, about a mile and a half further east, it dips S. W., at an angle of 25° or 30°, showing the underlying trap again on the east side. Between the Palisade rock and rock 540 seems to be a firmer trap rock, or rock resembling the Two Harbor rock, which appears in the bay east of Red Point, where it is cut by dykes.

The high range of hills that culminate in Mt. Josephine are made up largely of the rock No. 540.

At Grand Portage Island is a section of the rocks just lower than the "red rock," which here seem to have been preserved and thickened, as well as hardened, by local inflows of trap. The island itself is elongated east and west, but not much. It is rudely elliptical in horizontal form. Its highest parts are at the eastern end, where the bluffs, that face north are about 100 feet high. There is a gravel spit that is formed by the joint and opposite action of waves from the east and west as they whip round the sides of the island, jutting northwest from near the middle of the north shore, and from it a shoal extends still further in the same direction. The beach shows foreign drift-boulders, as well as many varieties of rock from the island itself, among the former being various porphyries and granites. The only piece of "Winnepeg limestone" found on the "north shore" was found on the northwest side of this island, though a fossiliferous piece of chert was picked up at Good Harbor Bay. There are also pieces of dark, hornblendic rock, and of micaceous schist that do not occur in the rocks forming the island, as well as a good many fragments of the "red rock." These last are so angular, and also so frail, that they seem not to have been far transported. They are perhaps from below the water of the lake south of the island, and are thrown up and brought ashore by ice and waves. Some of the "red rock" is rather sandy, and spotted with light brown spots, like the shale and sandrock of the St. Louis river, the spots being pink in the dark red. Some of the fragments are confused in structure as if crumpled, and are amygdaloidal; and some are harder and porphyritic, resembling the typical Palisade rock. The main beds of the island dip to the S. S. E. at a varying angle, and have an exposed aggregate thickness of 134 feet, viz:

541. At the N. E. corner of the island a dyke 10 feet wide cuts the quartzyte and conglomerate, running E. 10° N. by needle, without displacement of the bedding. It is a very fine-grained black, or blue-black rock.

542. A layer of trap like No. 540, which on the east shore is basaltic, rising about 12 feet. This is stratigraphically the highest rock in the island.................................... 14 ft.

543. A chalcedonic amygdaloid, though the chalcedony and calcite amygdules appear specially at the south east end of the island, may be.................. 20 ft.

544. A curious, dark, heavy, globuliferous trap-rock, disintegrating readily, the hard globules, which are of stony structure (not minerals) and nearly black, rolling out like shot, or bullets, and covering the ground after the rest of the rock has rotted to a greenish soil. The rock itself is chloritic and dark green. This is in a belt crossing the island east and west, appearing some like a dyke, but is in reality probably an overflow like the next underlying. Indeed it seems to pass into the next, in some places, showing it is only a local phase of a larger bed. It is the last to run under the water at the west end of the island, and at the east end it is the topmost rock in the bluff. Its thickness may be... .... 20 ft.

545. A bed of fibrous green trap, passing through the center of the island and forming its highest parts, and also producing a long sloping beach on the S. E. side running under the chalcedonic amygdaloid. In the center of the island it appears like a burnt scoria or slag, due perhaps to the effect of Nos. 543 and 542, though these have been removed in the central part of the island appearing now only along the south and southwest shores . 35 ft.

546. Sandrock, even-grained, rather fine, light colored, but of a pinkish and purplish cast, firm and compact in regular beds of 10 to 18 inches thick..... 8 ft.

547. Another bed of trap, like the dyke No. 541. This is sometimes brecciated, or finely and irregularly jointed, with white nodules of saccharoidal calcite.................................... 36 ft.

547A.—Nodules of saccharoidal calcite from 547.

548. Quartzyte, sometimes with mica specks between the beds, of a dark color, generally striped with red and brown, some of the beds being brown-red, with thin laminations, and some show ripple-marks.................................... 5 ft.

549. A breccia, or conglomerate-breccia, the cementing rock being a quartzyte like No. 548, or arenaceous like a grit.................................... 16 ft.

550. Near the dyke (No. 541) is another which cuts the beds, running E. 10° N. This is a little south of No. 541, and is 34 feet wide sloping a little to the north.

551. Another dyke crosses the S. E. corner of the island in direction N. N. E. by E. and is of a coarse dolerytе. It is probably due to these dykes that the island exists, as by their intersection their effect has been to harden the beds, and to present toward the east the apex of a triangle to ward off the waves of the severest storms.

There must be, besides the foregoing, also the following nearly associated with them—although they do not appear any where in the bluff soft he island—since they are seen in fragments on the beach.

(a). A true pebbly conglomerate, or coarse grit, nearly white or of a light color.

(b). A true conglomerate like (a), but containing pebbles, at least crystals, of red feldspar.

(c). A conglomerate with few pebbles, but a green aluminous, or chloritic cementing material.

The true place of these cannot be ascertained, but (a) is probably near the bottom of No. 546, as well as (b), and (c) resembles the shale and sandrock cut by dykes in the bay east of Red Point, (Nos. 232 and 235), which must be just under the "red rock," and so probably belongs near the top of, if not wholly over, the foregoing section. Indeed it must come, in that case, from the lake, below the water.

A generalized section of the alternating beds of the formation as they occur along here would be as follows in descending order:

1.	The Palisade rock, or the "red rock."	
2.	Green shales, &c., in the bay east of Red Point, (Nos. 232, 235, 238 and 239).	
3.	Layer of trap like 540 (No. 542)	14 ft.
4.	Chalcedonic amygdaloid (No. 543)	20 ft.
5.	Fibrous, green trap striking E. and W. through the island and forming its highest parts. In spots it is globuliferous with hard, dark, strong, shot-like pellets about ¼ in. in diameter, (Nos. 544 and 545),	35 ft.
6.	Even grained sandrock (546)	8 ft.
7.	Trap bed, finely and irregularly jointed, with nodules of white saccharoidal calcite (No. 547)	36 ft.
8.	Quartzyte (No. 548)	5 ft.
9.	Conglomerate (No. 549)	16 ft.
10.	The rock No. 540, forming the great trap covering of the quartzyte hills at Grand Portage, 50 ft.	250 ft.
11.	The slate and quartzyte terraces seen in the hills at Grand Portage, generally and along the international boundary as far west as the west end of Gunflint lake(estimated)	400 ft.
12.	The jasper and iron ore beds of the Misabi, and southeast of Vermilion lake.	
13.	The micaceous and chloritic schists and slates of Vermilion lake and the Dalles of the St. Louis river.	
14.	The mica schists, granites and syenites of the region north of Gunflint lake, (V. after No. 753).	

This takes no account of the great labradorite range, which in some places forms the Mesabi, nor of the iron ore deposits of Mayhew Lake, because they are apparently included in the rock Nos. 258 and 540, or in an immense outflow of molten matter at a date somewhat earlier. (V. Nos. 695 and 816.) Nor does it mention the conglomerate of Ogishkie Muncie lake, because that is apparently an incident of the slaty and talcose beds included in Sub. No. 13, nor the red granites of the region of Brulé Mt. because they are probably a modified condition of the Palisade rock.

Nine dykes are seen crossing Hat Point on the west side of Wauswaugoning bay, cutting the slates and quartzytes near the water, running a little northeasterly varying from 3 feet to 70 feet wide. A heavy dyke of basalt runs along the head of the bay terminating the bay in that direction. It cuts the slates, hardening and solidifying them so that their walls, broken and oblique, sometimes stand alone, appearing like other dykes. It runs on into the "Cypress Swamp," of Norwood, and appears to be the same that forms little islands in the south arm of Pigeon Bay.

552. Plumbaginous quartzyte, Pigeon Pt., near the trail to Parkerville. Sec. 32, T. 64, 7. (V. No. 270.)

553. Quartzyte, near the portage trail, at the north shore.

The Grand Portage range of hills laps over another as it approaches Parkerville, and also gradually dies out, the Pigeon river coming through the low spot in the valley between them. The other range runs along the north side of Pigeon Bay, in Canada, turning a little northwest as it approaches Parkerville.

554. The "Two Harbor Rock," (?) from the east end of the island most easterly, separating Washington Harbor from Grace Harbor, on Isle Royale. This is more coarsely jointed than the Rock at Two Harbor, and has somewhat the appearance of an imperfectly basaltic dyke, but as it develops a few rods further north it appears as an overflow, t least it lies on other trap and amygdaloid. It forms a little boat-harbor where fishing shanties are erected. It is at least a fine-grained brown, trappean rock, and in this section seems to hold no free quartz.

The south side of Grace harbor is of pebbles and stones, the pebbles derived from a red conglomerate that occasionally is seen in the beach, but which in the S. W. corner of Isle Royale is finely exposed. This red conglomerate is coarse, some of the stones being over a foot across, and dips for a long distance gently toward the south and southeast. On approaching the point in the coast nearly south of Siskiwit bay, the dip increases, and still more toward the entrance to Siskiwit bay. Above the conglomerate appears a red sand-rock, nearly a red quartzyte, resembling rock No. 548 of Grand Portage Island. This has regular bedding, cut into cuboidal or rhomboidal blocks by divisional ripple-marked with some softer, shaly or hæmatitic laminæ, and with hæmatitic lumps of shale more or less inclosed in the mass of the beds themselves. Some of these beds are about 30 inches in thickness, and some are less than an inch. These beds are firm and durable, blackening under the waves like a trap, to which at a distance they have some resemblance. Its dip, color and bedding recall the red quartzyte in S. W. Minnesota, but it is rather less siliceous than that. In the same manner, however, it overlies a coarse pebbly conglomerate, which in the same way indicates its relations to the red quartzyte of Grand Portage Island and of Pigeon Pt. peninsula (No. 290), as well as to the red sandrock and shales of Fond du Lac.

At Grand Portage Island it appears that a trap inflow separates the red sandstone and shale formation into two parts, only a small portion being below the trap, the greater portion being out in the lake further south, while on Isle Royale no such trap overflow divides it.

555. Red quartzyte or sandrock from Siskiwit Point, Isle Royale (the point that encloses Siskiwit Bay). This has been quarried further west in the bay, on the south shore, and advertised in Detroit under the title "Isle Royale Brown stone," by Buchan & Co., 117 Griswold St. West from the point, on the south shore of the bay this rock stands out prominently, dipping from 10 to 20 degrees to the south, forming a jagged and rocky coast, having a perpendicular rise from the water the most of the distance to the first bay on that side. Altogether there must be three or four hundred feet in thickness of these beds, involved in the point that shuts in the bay, but they actually rise above the lake but about 60 feet. The former beds do not lie immediately on the coarse conglomerate, but are separated from it by a shale, which appears at the point forming the first little bay west from Siskiwit Point. This red shale, though appearing rocky, breaks with a sectile fracture, into a great many small pieces when struck with a hammer. It is bedded like the quartzyte, but is intersected by numerous *gashes*, or gash veins, which are of a very different color, being greenish, or greenish gray, and about one-fourth to one-half inch wide and but a foot or two in length, running nearly north and south as they appear on the weathered surface, though some are irregular in direction and follow other cracks. These gashes seem to have been caused by the change produced in the rock by the gases escaping through fissures produced by the disturbance of the formation, rising from heated regions below, rather than by the downward effect of heat from trap overflows. This shale is the most destructible of the whole formation, and probably is

mainly the cause of the low swampy land that intervenes between the head of Siskiwit Bay and the S. W. corner of Isle Royale. The conglomerate itself is under the shale, and is more durable.

556. Red, hardened shale, south shore of Siskiwit Bay, as above described.

The same red conglomerate that forms the S. W. end of the island also forms the north coast of Siskiwit bay, and is the rock containing the copper at the Island Mine, which is near the head of the bay.

557. Cupriferous conglomerate, from the Island Mine, Isle Royale near the head of Siskiwit bay; this is also argentiferous.

557 A.—Variety of pebbles from the conglomerate, 43 kinds.

557 B.—Stamped rock and copper. Island Mine.

558. Amygdaloidal dark trap, near the stamping mill of the Island Mine, Isle Royale. This is near the creek coming through the location.

558 A.—Wernerite, from 558. This mineral has the following chemical and blowpipe reaction:

Blowpipe Reaction of No. 558 *A.*

Fuses at 2 or 2.5, with intumescence.

After fusion gives a quick alkaline reaction when moistened on turmeric paper.

Gives no sulphur reaction on silver.

Salt of Phosphorous bead shows a skeleton of silica.

H Cl. solution does not gelatinize.

H Cl. solution gives no precipitate with Ba Cl.

H Cl. solution gives slight precipitate with NH_4 HO.

In closed tube, B. B. gives no water or the slightest trace only.

Fused and moistened with H Cl. gives a copper flame.

Some fragments effervesce slightly in H Cl.

H Cl. solution gives no precipitate with S. O.

Hardness 5 or 6.

Color, light, lilac-gray, or a pinkish white, or white.

Structure, massive, or fibrous and divergent, the rays becoming separated, acicular, tetragonal crystals.

H Cl. solution does not give titanium reaction with tin.

Borax bead is slightly yellow from iron.

H Cl. solution does not gelatinize even after boiling.

After fusion the H Cl. solution gives no jelly.

These characters bring the mineral between Wernerite and Cancrinite. The occasional effervesence allies it with Cancrinite, but its color and the tetragonal form of the fine crystals show it to be Wernerite. The effervescence is probably due to something attached to the fragment. This mineral is in amygdaloidal cavities or irregular openings in the trap, some of the masses being two inches or more across.

558 B.—In 558 are veins of a green rock which is heavy and amygdaloidal with what also appears like Wernerite.

559. Trap that immediately overlies the cupriferous bed of conglomerate, at the Island Mine.

560. Trap that forms a bed under the cupriferous conglomerate, known as the *Greenstone Range* where it rises to the surface further north.

561. Decayed rock, or volcanic ash, so-called by Norwood, from the cupriferous bed of the conglomerate.

At the location of the Island Mine, a beach, apparently formed by jamming of ice, is 95 feet above the water. The road from the dock to the mine runs on it some distance. There are other beaches or ridges, lower, some of them running somewhat transversely across the intervening space. These are short, and more evidently due to the jamming of ice. The 95 feet beach is the upper limit of a strictly pebbly surface; above that the surface being one of loam and gravelly clay, or a stony loam, so that there may be said to be a soil. Below the top of this ridge, as well as wholly over it, there is absolutely no soil,—only red gravel and stones derived from the conglomerate, with an occasional out-crop of the conglomerate itself.

The conglomerate slopes southward into the water of the bay all along the shore, but between the shore and the mine several trap and amygdaloid beds appear, having a bearing, or strike, apparently in the direction of the coast, the whole of them being near the mine. The location of the mine is from 250 to 300 feet above the lake, and about a mile north from the bay The shafting is in the conglomerate rock lying between trap beds, and slopes towards the south with the dip of the formation.

There is some coarse sandstone, or grit, disseminated among the conglomerate, some beds being a foot in thickness, but fading out to the right and left.

The mine is not now worked (1879) and has not been for a couple of years. There is not a man, woman or child here, but there are many houses, stores, shops, and offices, including a Court House, this being the county seat of Isle Royale county. Everything is deserted. The machinery is mostly still here. The cars, shovel, and various accoutrements lie simply abandoned. The mills are perfect, the enginery for stamping and washing the ore being still on the ground and in good condition.

Toward the east from the dock of the Island Mine the coast is wholly occupied by the conglomerate, or by the overlying slate and sandrock, as far as Wright's Island, but the beach much of the way is formed of drift-brought stones.

562. Trap, somewhat decayed, from a niche in the coast line, south of the east end of Siskiwit lake. This is under the sandstone, but over the conglomerate. It rises from the water with a dip to the south. It has involved with it irregular beds of a porphyritic, harder rock, and patches of epidotic green rock.

563. The porphyry is finer than the porphyry of the pebbles of the conglomerate, but it seems possible that these porphyritic belts may come from a metamorphism of patches of that conglomerate holding such pebbles. The trap is confusedly bedded. The porphyry is also amygdaloidal, mottled with green and red-brown, with white calcite. At Chippewa harbor beds of sandstone and shale are between beds of trap, visible on both sides of the entrance dipping about 35 or 40 degrees to the south. On the east side but one bed of sedimentary rock is visible. It has a thickness of perhaps 75 feet. The overlying trap rises perpendicular perhaps 45 feet. A little further west a trap rises from below the sandrock and shale, and west of that another lower bed of fine shale appears in the coast line, the last being about 10 feet thick. On the west side, near the entrance, are visible two beds of shale and sandrock, alternating with trap. The trap contains fragments of shale and of angular quartzyte along a thickness of about a foot just over the shale-bed. The trap separating these beds of shale seems to be about 120 feet thick. That on the top of them, which also forms the coast line either side of Chippewa harbor, is also about 100 feet thick, and over that is much more sandstone, forming islands off the coast five or six miles west of the harbor. Chippewa Harbor enters nearly at right angles to the strike of the rock-beds, but after passing the narrows it turns more southerly and passes along the strike behind the bluffs formed by the foreging layers.

564. A white mineral from the trap at Chippewa Harbor, on the east side near the entrance, appears to be the same as the Wernerite from the trap at the Island Mine, but it has somewhat the appearance of pectolite. In this lot are also some green amygdules which are closely associated with the Wernerite in the rock.

565. Calcite, from a mass on the beach, containing a green radiated mineral like prochlorite, also Wernerite, and a little quartz.

566. From an amygdaloidal bed of trap that disintegrates, near the narrows of Chippewa Harbor. These green amygdules appear some like chlorastrolites, but they are probably some form of chlorite.

They have a radiating, fibrous interior, sometimes several centers in one mass.

The trap-rock of Chippewa Harbor, without exposed sandstone, continues to the little bay next south of Conglomerate bay, known as Lucky bay, where the rock is of the same kinds and probably of the same horizon as Nos. 562 and 563.

567. From Lucky bay, showing a passage from porphyritic trap to non-porphyritic. This porphyry is from the trap of the place, but it is in patches, or lenticular beds that are generally less than a foot thick, the mass of the rock being porphyritic; but sometimes having a few amygdules of green chlorite. The face of the rock shows a spotted surface when water-worn and partly decayed like much of the trap of the north shore.

568. Trap-rock, taken from the Saginaw Mine, near Conglomerate bay.

569. Epidotic rock, from the Saginaw Mine, the same being the ore of the vein mined for copper.

570. Amygdaloid containing calcite, chlorastrolite and chlorite, from the rock at the light house at the entrance to Rock Harbor.

570A. Chlorastrolites picked from the beach at Rock Harbor.

570B. Green "thomsonites," chlorastrolites, &c., from Rock Harbor.

Conglomerate bay has no conglomerate at the entrance, but toward the head of the bay it is found. The trap is crumpled and faulted between Lucky and Conglomerate bays, and dip generally E. S. E.

At the Siskiwit mine the work was on a vein of epidote and calcite. In the islands opposite is a bed of conglomerate, embraced between trap beds.

571. Samples of trap and gangue rock, from Siskiwit mine, Rock Harbor.

572. Trap rock from Scoville's Pt., Isle Royale.

573. Radiated, white, fibrous, zeolitic mineral from the trap at Scoville's Point, picked up on the beach.

574. Trap rock from the extremity of Black's Pt., east end of Isle Royale.

575. Thomsonites (?) and other zeolitic minerals, from the beach of the mainland, north shore of Isle Royale, about two miles S. W. from Lock's Point.

576. Prehnite and copper (some attached to the amygdaloid from which they come, from the little bay at the east extremity of Fish Island).

577. Black oxide of copper, from the Minong mine, Isle Royale, attached to a large piece of the rock.

578. "Stamp ore," showing the nature of the rock in which the copper occurs.

579. Shows an occasional form of the rock in nodules, also included in the "Stamp ore."

580. Coarse green amygdaloid, the cavities being filled with chlorite or with geodic quartz with interior rosettes of chlorite, coated with green—the amygdules making up more than half of the bulk of the whole. It also shows some calcite and some laumontite. This adjoins the copper-bearing rock.

581. Native copper, from the Minong mine, Isle Royale.

582. Native alloy, and intimate mixture of copper and silver, Minong mine, Isle Royale.

583. Native copper, with attached crystals of—?

584. Battered copper, found about the large masses worked by the ancients.

585. Stone hammers used by the ancient miners at the Minong mine, Isle Royale. These are generally rounded or oval pebbles of fine basalt, evidently transported from the north shore of the lake, where they got their form by the action of the waves on the beach. They are not withed*. They are found in the debris about the old pits

586. Wood, found in the ancient dumping heaps.

At Silver Islet the shaft in 1879 was 720 feet below the level of the lake. The vein runs about N. and S. in the slates and quartzyte of the region, and varies from almost nothing towards the north to ten or twelve feet in its greatest width, which is where it intersects diorite dykes running N. E. and S. W. (said to be E. and W.) The dyke is set off where the vein crosses it, the east side being further to the south than the west. The richest deposits are near the intersection of the vein and dyke, and are accompanied with plumbago which has seggregated from the organic matter contained in the slates. The gangue-rock is a breccia of slate, filled with calc-spar and quartz, though mainly calc-spar. The silver is native and is disseminated through saccharoidal calcite. It is also found in the galena, but in general the galena is discarded. There are also blende and pyrite. This silver has been lately found combined in new forms with arsenic, antimony, &c., &c., creating new mineral species—Huntilite and

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* See the *Popular Science Monthly* for September, 1881, for an account of these ancient miners, by the writer.

Animikite. The vein seems to have been enlarged in passing the dyke and charged with these minerals. The work is now being pushed north and south, in hope of striking other dykes. In the vein are large spar-lined cavities in which gas accumulates, (carburetted hydrogen) which has caused some trouble from its slightly explosive character. Water gathering in the mine is strongly charged with some gas, probably the same, but at the bottom of the mine in the "diorite" rock, no water accumulates, and it is necessary to carry down water to serve the drill which is driven by compressed air, the same operation ventilating the shaft. The great deposits of native silver have been in near connection with the dyke, and the large cavities with calcite and galenite are in the same way related to it. The plumbago is along the hanging wall, and is closely connected with the "diorite" of the dyke—indeed is permeated sometimes with igneous rock matter.

587. Calcite and galenite masses with crystalline points perfect. The galenite here is in octahedrons instead of cubes.

588. Mass of octahedra of galenite, Silver Islet.

589. Plumbago, Silver Islet.

590. "Diorite," from the bottom of the mine, Silver Islet, 720 feet below the level of Lake Superior.

591. Saccharoidal spar, which is the gangue-rock.

592. Cemented breccia, from the vein.

593. Igneous rock, from the vein.

594. Slate, that incloses the vein.

595. Cores of the diamond drill, Silver Islet,

596. Stamp ore, with saccharoidal, flesh-colored calcite. Silver Islet.

596 A. Huntilite, from the Silver Islet mine, an arsenate of silver, antimony, cobalt, &c. (Wurtz.)

The following general section was taken at Silver Islet Landing. Some of these beds are seen only at a mile or two north from the lake. It is given in descending order.

(1.)	Mottled, red-and-bluff, fissile shale, checked and crumbling into small angular pieces; below conglomeritic and lighter colored, siliceous limestone and chert predominating, ashy and loose........	40 ft.
(2.)	Light-red dolomitic sandrock, some parts being red sandrock, weathering generally of a light color	35 ft.
(3.)	Siliceous conglomerate, with rounded pebbles......	5 ft.

(4.)	Greenish, weathering dark, fissile sandrock, appearing at a distance like thin-bedded slate—really fine-grained and aluminous, apparently the top of the slate and quartzyte in which the silver occurs. The transition is gradual from a hard quartzyte and slate, near the bottom, to an arenaceous slate, through a greenish color which is first brownish and then reddish, thus getting the color of the beds higher still. Seem	55 ft.
	Seem total	135 ft.

There is, presumably, slate to the thickness of about 50 or 60 feet more, hid by tubes. The above are all conformable, so far as can be seen here, and are cut by "diorite" dykes running to the top.

597. Fissile, mottled red-and-buff shale, from No. 1 of the foregoing section.

597 A. Siliceous and cherty, with calcareous nodules, from the lower, and conglomeritic, portion of 597.

598. Light-red dolomitic, sandrock, compact, mixed with red sandrock, from No. 2 above.

599. Siliceous conglomerate, from No. 3 above.

599 A. Pebbles from 599, water-worn.

600. Greenish fissile slate, from No. 4 above. Aluminous and fine-grained. The samples are rather too quartzose to fairly represent the bed. They are from the lower portion. The higher beds are softer.

601. Coarse porphyritic "dioryte," in a dyke running parallel with and contiguous to and passing into

602. A fine-grained dioryte, in the form of a dyke. The interval of transition is perhaps two feet wide and the crystals of feldspar are scatteringly disseminated through it on the south side, and wholly disappear on the north side. They run in the same direction as the dyke on Silver Islet. The whole is 45 feet wide, but is evenly divided between Nos. 601 and 602, from about a mile north of the "Landing" at Silver Islet.

Pigeon River Falls are formed by the range of hills of trap that set in near the head of Wauswaugoning Bay. The range is an immense dyke cutting the slate, and continues east so as to make the peninsula that separates the bay into North and South Arms, but undulates up and down. It is in one of the downward undulations that the falls occur. Probably more of these hills than has been supposed, are simply dykes piled up over the fissure when the rock was molten, sometimes flowing over. Hat Point and Mt. Josephine are thus dykes.

603. Porphyritic dioryte, such as cover the hills of quartzyte and slate at Pigeon Pt. From the extremity of Pigeon Pt. (V. No. 291.)

604. Black, fine-grained, hardened slate, from south of the dyke (No. 605) on the point next east of the little bay where the portage passes over Pigeon Pt., on the south shore of Pigeon Pt. The portage is 87 paces over, from the top of the beach on the south side to the same on the north side, and passes wholly over moss-covered, loosened fragments of rock.

605. Dyke-rock, cutting the slates and quartzyte, 35 feet wide, at the bay where the little portage crosses the point.

606. Rock of the surface next north of the dyke, in contact with it.

607. Modification of the quartzytes next north of the dyke, and under No. 606, fine-grained quartzose syenite, some of it not showing orthoclase.

608. Fine-grained, reddish quartzose syenite, a modification of the quartzytes, under No. 606.

609. Similar to the last, but further from the dyke No. 605.

610. Similar to the last, but more red, further from No. 605.

611. Red, fragile syenite, a further modification of the rock underlying the rock No. 606, and further within the bay.

612. A further modification of the same beds or underlying beds, from a few feet within the bay toward the portage trail, northwesterly from 604. This is evidently mingled with igneous matter, though having a slightly red color. There is a fine cross-jointage in 610 and 612 that resembles that of some igneous dykes, but this is not anywhere seen.

The relations of 607—612 to the dyke and to the quartzyte cannot be stated positively, for the whole situation is confused, yet the position of the beds from which they are derived is such that they would succeed each other in descending order. No. 604 seems to be the quartzyte hardened. It forms a surface sloping to the lake. It is cut by No. 605, but as 605 rises five or six feet above the lake it comes in contact on the north side with 606, which, while so situated as to be the apparent continuation of 604, has a very different lithology. It is much like the rock 603, at the extremity of the point; is coarser-grained than 604, but has free quartz and horn-blende. No. 606 overlies the numbers following to No. 612. These last cannot be said to come exactly in the order numbered, but probably do approximately. The layers are in strata and dip S. or S. E. weathering out thin-bedded.

The samples did not come from successive beds, but rather at increasing distances along the beach, somewhat descending in the strata. The fragile parts (Nos. 611 and 612) are at once followed by the pebbly beach where the portage trail passes over to the north side. These are piled in successive steps upon each other to the height of 15 feet, and continue across the bay. It was doubtless owing to the occurrence of these soft beds, which rot and chip up, under the water and ice of the lake, that the break-down in the peninsula exists here.

613. On the west side of this little bay the point consists of rock like some of the rock on the other point (607—612), but is hard and firm. It has a resemblance to the plumbaginous quartzyte (552), but with the naked eye no plumbago can be detected.

614. Near the point a dyke cuts this rock, blackening and hardening it. The dyke seems to dip N. E. so as to stand at right angles to the dip of the quartzyte, and the north wall is very distinct, the dyke having been torn away by the lake.

615. Rock of the above dyke.

This dyke, which is 12 feet wide, has not the direction of that on the other point, but runs out into the lake S. E. while that on the other point seems to run into the bay, lying to the north of this. These dykes each point toward a hill of quartzyte near the coast a short distance west.

616. Further within the bay, on the west point, the rock bluff facing east is reddish and mottled, like much of that on the other point. Sometimes the prevailing color is red, and sometimes green, but the colors do not apparently change in any observable regularity, or in accordance with the strata. By far the greater portion on the west point is red, while on the east point a green color is more common; bands and veins of red run through the green, or *vice versa*.

The two dykes mentioned at Little Portage bay converge toward a hill near the south coast—indeed the rock forming the point (613) seems to rise and culminate in this hill, though the hill is at last sudden in ascent on nearly all sides. It is about one-half mile west of the portage.

617. From near the base of the hill mentioned, a reddish gray quartzyte.

618. Gray quartzyte, from the top of the same hill. This hill is with the exception of that back of Clark's Bay, the highest on the peninsula, and consists of metamorphosed, highly inclined, basaltified, gray quartzyte. The softer beds that allow of the narrows in the

peninsula form a belt of low land running north of this hill, and striking the north coast N. W. from the hill.

There are four principal elevations on the peninsula. 1st. East of the narrows, forming a basaltic bluff perpendicular from the water on the north side of the point. 2nd. The quartzyte hill near and west of the Little Portage bay. 3rd. Hill at the head of Clark's Bay, north of it. 4th. The hill range cut by the Parker vein. Of these the third is the highest, being about three hundred and fifty feet above the lake.

619. From the same hill as No. 618, on the south side where the structure is basaltic.

This quartzyte assumes forms, structures, colors and positions that give it a very great resemblance to igneous rock. It is often finely or coarsely basaltic (at least cut by numerous N. and S. parallel points), and sometimes rises suddenly to the height of over one hundred and fifty feet. It is dark gray, greenish, red, black. It is globuliferous, or at least disintegrates in a rough or cavernous manner somewhat like trap rock. It is porphyritic, with feldspar. These characters do not combine, but occur separately, and it can hence generally be identified.

620. Rock of the E. Palisades (V. No. 230). This rock is red on weathering under friction, but, being coarsely fissile, or shaly, cut by innumerable seams, it rarely fractures freshly but parts into small augular pieces by a blow from the hammer, showing only greenish coatings in the seams. Its true fracture is ragged. This rock has fine translucent grains of quartz resembling those of the Great Palisades and a general outward resemblance to the rock of the Great Palisades.

621. Thomsonites (?) &c., from a short beach at Lover's Bay. The trap that encloses this bay is dark, but slightly greenish, and amygdaloidal with Thomsonites and Wernerite. They are few and dull in color. They are generally of a pink color, or massive and white. (See after No. 192.)

622. Stilbite, thomsonite, calcite &c., mouth of False Poplar river.

623. Dark, greenish trap, forming the upper layer of the point that encloses Eclipse beach on the east. This is two and one-half feet thick, not amygdaloidal, but very chloritic from decay.

624. Laumontitic amygdaloid, lying below No. 623. This has some stilbite and some thomsonite. This bed by easy disintegration forms two small harbors, one protecting from the N. E. and one from the S. W. The beach of the west harbor is of gravel, and has many thomsonites, but the east harbor is entirely rock-bound. This bed is

about eight feet, but varies some, as the characters of No. 623 fluctuate up and down. The general color is a dull red.

625. Greenish trap, having much thomsonite, prochlorite and some stilbite. From this bed the thomsonites of Eclipse beach weather out. Some of the masses of thomsonites are three or four, or even ten inches across; but in the case of large masses the mineral lies rather in sheets, with radiating points on the upper and lower contact surfaces. Some large masses two inches across also have two or three points of radiation. When polished on the beach the pieces which result from the destruction of the large masses are prismatic, but there are also many round and oval which have not been broken on separation from the rock. These show the circular radiating results of different colors on the outer surfaces when polished on the beach. The colors are pink, red, white and green,—at least thè same green mineral is found here, always smaller than the other thomsonites, as is found at Terrace Point. This green mineral often surrounds the pink and white radiating masses of thomsonite. It is itself not evidently radiated, and the radiations of the thomsonite penetrate it.

This rock is very nearly, if not exactly, on the same horizon as the trap at Terrace Point, judging from the run of the beds, as they extend along the coast from that place. The same horizon extends to Poplar river without much deviation. Some thomsonites are to be seen on the beach at Poplar river. The thickness of No. 625 cannot be made out, as it forms the coast-line eastward. (V. No. 187.)

625A. Thomsonites, picked from the rock at Eclipse Beach.

625B. Thomsonites, picked from the beach at Eclipse Beach.*

626. Red laumontitic amygdaloid, from about mid-way between Poplar and Temperance rivers (Nos. 177 and 178). This is in regular beds, of a few inches, or less than an inch, lying like a sedimentary rock. The general color is pinkish-red. These specimens may represent the red amygdaloid of several miles along here, even from Poplar river, though the sedimentation is not so plain in all cases. Over them here is a heavy bed of trap, massive or coarsely jointed. This trap bed forms arched purgatories, and tables extending over the lake, where it extends down to the water, the amygdaloid being eaten out by the lake. Occasional thomsonites occur here on the beach.

From two or three miles east of Temperance river to about half way to Poplar, is a very picturesque and interesting, but difficult coast.

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*This is called Eclipse Beach, because in 1878, in the latter part of July, our boat was driven in here by high wind, and during our enforced stay in the afternoon, the sun was eclipsed about half an hour. Being compelled to spend the night here, our camp was pitched on the bluff and between the two harbors.

The trap and amygdaloid form a thousand fantastic shapes, as the line of the lake level cuts across the undulations of their bedding and change of dip. Sometimes the bridge of trap rock, produced by the eating away of the soft underlying amygdaloid, runs intact down to the lake, forming deep reverberating purgatories in which by the confinement and compression of pockets and chambers of air, the waves that close up the entrance are thrust back quickly again. Sometimes the bridge breaks down, leaving islands of rock just off the line of coast. Sometimes bridge, islands and all are taken away, letting the lake break on the base of the high bluff rising often perpendicular from the water, or skirted by a narrow pebbly beach, a few rods inside the line where the islands had existed. The effect of wave-and-frost-action on a line of stratigraphy of alternating hardness could not be more perfectly illustrated.

627. Dark trap, forming an arched rock at the shore three-fourths of a mile west of Cross river. The eroded bed is one of two feet thickness of stilbite-thalite-laumontite amygdaloid, which lies on a firm bed of trap having thomsonite and stilbite with less thalite.

628. Basalt; mouth of the Manitou river. At this place about thirty feet of trap that shows red surfaces in falling to pieces, lies on an amygdaloid conglomerate, the two together forming precipitous bluffs on either side of the river, with lower stretches where the trap, which is basaltic or semi-basaltic, runs unbroken down to the water. This kind of coast runs east at least to the point west of Pork bay and west to Little Marais. (V. No. 160.)

629. Conglomerate, from the mouth of Manitou river. The conglomerate is crumbling, soft, red, amygdaloidal, the form and original structure of the pebbles being obscured or lost in the metamorphism.

Over this conglomerate at Manitou river the trap (628) is basaltic. Along the coast it greatly resembles the Grand Marais trap. The basalt is bedded, or at least jointed in the direction of the dip, so that the columns break off in pieces a few feet long, leaving a smooth surface below, but one, on which the outlines of the tops of another tier of columns can be seen, and which is itself broken away at a lower level, so as to disclose another tier still lower. Thus in successive benches, or tiers of columns the bluffs ascend somewhat irregularly from twenty to eighty feet. Sometimes one of the lower tiers is not broken, but like a dome rises gradually from the water and runs under one of the upper tiers. This regularity is not the invariable form of the breaking away. Instead, a very rough surface, caused by the separate and individual fracture of the columns all over, sometimes runs down to the lake level. This is the case in approaching Little Marais from the east, where at the point the whole range of trap strikes southwardly into the lake and disappears under the water, forming a ragged, rocky point, and letting the coast line on to the conglomerate, which is but little seen, the only exposure being just at the point on the west of the strike of the trap.

630. Green, chloritic trap, from two miles west of Little Marais Point, forms perpendicular bluffs.

631. Green chloritic amygdaloid, from the same place.

631A. Red, compact, rock-like veins in 631. This red rock, which seems to be foreign to the rock 631 in which it appears, is found embraced in veins with stilbite and calcite.

West from Little Marais beach, the first little point is formed by a trap exposure which probably lies below the conglomerate. This continues west under a stony beach for a mile or so, when, with a high dip, it begins to show more and more, and finally to make a continuous bluff twenty to forty feet high. This trap (630) has a very different aspect from the Little Marais trap, being green instead of red, the amygdaloidal portions also being green. It contains stilbite, calcite, chlorite, (thalite) and some thomsonite. This trap and amygdaloid are bedded, but not basaltic. Running through it are seams, one and two inches wide, (631A.) which are made up of layers of stilbite and a red rocky substance that resembles the rock Nos. 7 and 42. On the beach are amygdules of quartz and thomsonite. This rock, taken all together, much resembles the rock at Eclipse Beach, and perhaps, if the horizons could be compared, it would prove to be synchronous in origin.

A little further west, as Nos. 630 and 631 rise above the beach, a reddish amygdaloid is brought into view, which on close examination proves to be a conglomerate. This rises, as the anticlinal bend of the trap passes inland so as to show about thirty-five feet with purgatories in a perpendicular bluff. Under it soon appears another trap which also rises in anticlinal, is broken away by the action of the lake, and discloses in an eastward facing bluff a lower conglomerate bed of unknown thickness. This anticlinal covers about a mile and a half. The beds return to the lake again at the headland about one-half mile still further west. This is on Secs. 29, 30 and 31, T. 57, R. 6, about three miles west of Little Marais.

632. Trap, from a point of rock on Sec. 29, T. 57, 6, separated from the green trap 630 by a conglomerate thirty-five feet thick. This is red in many spots, on account of the red partings along all the

joints, styled heulanditic by Norwood. It is crossed by red siliceous seams about one-half inch thick, and has large lumps of quartz and geodes. These red veins resemble the red vein material of 631A. but not so abundantly accompanied by stilbite. Thickness 12 feet.

632A. Siliceous, jaspery seams from trap No. 632, from a point about one-half mile west of where 630 appears.

632B. In the same beds of 632, or which at least contain 632A. are siliceous geodes, lined sometimes with amethyst, and a great many agates. These are in a bed but little above a conglomerate, and seem to have been derived from the fusion and dissemination of the material of the conglomerate, the same cause doubtless as filled the siliceous veins of 632A. In some geodes the central mass is laumontite.

633. Thin, irregular beds of trap, immediately under 632, containing red amygdules.

634. Nearly the same as 633, but underlies it; this seems to be a heulandite amygdaloid. It is near the top of the conglomerate. It also contains agate, stilbite, laumontite and chlorite. The red coatings and the heulanditic characters prevail along the red seams that cross and re-cross the rock. In some cases the red mineral penetrates the whole and is disseminated generally through the mass in the manner of amygdules.

634A. Amygdules of "heulandite," and of agate, stilbite and chlorite, picked from No. 634.

634B. Stilbite crystals from 634.

635. Greenish, rather soft, fine, sub-crystalline, compact crumbling rock, containing siliceous nodules. At first this polishes under the friction of the waves, but after long exposure it crumbles from the abundance of chlorite. It lies under No. 634 and also has heulandite in the upper portion. Nos. 633-35 have a thickness of only three or four feet, and are variously affected by proximity to the conglomerate.

635A. Stilbite amygdaloid, containing also agatized nodules, jasper, &c., lying below 634. The heulandite material coats the amygdules and all seams and joints; contains some chloritic amygdules.

Beginning with the Little Marais trap bed the succession downward appears as follows in going west along the coast:

1.	Little Marais trap, Nos. 160 and 628	30 ft.
2.	Amygdaloidal conglomerate (No. 629)	50 ft.
3.	Green trap, (two miles west of Little Marais, Nos. 630 and 636,	50 ft.
4.	Crumbling conglomerate, amygdaloidal, seen	35 ft.
5.	Trap, with heulandite (No. 632)	12 ft.

6. Trap, amygdaloidal with heulandite (?) (Nos. 633-4-5,.. 5 ft.

7. Amygdaloidal conglomerate. Thickness unknown.

636. Samples of red granite; resembles the red granite at the west point of Beaver Bay, but is coarser than that. At a distance this is apt to be mistaken for the Palisade rock. Sec. 1, T. 56, 7. This makes a high point, with a perpendicular face toward the S., but there is only a small area of it in the formation. (V. No. 157). This rock passes by slow changes into the Palisade rock. It appears at a number of other places along this part of the shore. (V. No. 643.)

637. Feldspar rock, Beaver Bay, at the west point of the bay, (V. No. 120).

637A. A light flesh-colored mineral, with a radiated structure, in scales filling seams in No. 637. The scales are generally about one-fourth inch thick, but are sometimes one-half inch.

638. Rock at the base of Encampment Island, from the north side of the island, (same as 106).

639. Green, heavy doleritic trap, coarse-grained, from the high bluff about a mile east of Silver Creek. (V. Nos. 105, 819.)

640. Two Harbor Rock, separated from No. 639 by a red amygdaloid, eighteen to twenty feet, as at Two Harbors; at the water level, under the hill formed by 639, about a mile E. of Silver Creek.

641. Trap amygdaloid, Knife river, grayish green, containing thalite and chlorite. (V. No. 91.)

From Grand Marais to Ogishkee Muncie Lake, and Mouth of Poplar River.

The hills that lie near the mouth of Silver creek, and that extend in a chain N. E. from here, are the first of that form and outward aspect similar to the Mt. Josephine class, that can be seen from the tug-boat in going down the shore from Duluth.

The range next east of Carlton's Peak has the same outward form but Carlton's Peak itself is different. Between Carlton's Peak and Poplar river are four prominent hills, rising about as high as Carlton's Peak. West of Carlton's Peak for a long distance, is an unbroken line of continuous high land, but further west still is a very ragged range of hills.

East from Poplar river are two gentle swells of high land at once; then the high land is more even-topped, gradually descending to the coast at Cascade river. The range appears double at Poplar river, a high hill farther inland overlapping the gap at both ends. The same is true at Cascade river.

In passing toward Grand Marais some of the hills, which do not from the S. W. show any semblance to the saw-teeth structure, change their profile, and fall into line as parts of the regular range. The range thus runs to Grand Marais, where it seems to fall away, or to recede from the coast.

The appearance of the hills suggests that the Silver creek range, already mentioned, having the outward appearance of those at Grand Portage, is of the same geological structure, and that the range east of Carlton's Peak, extending to Grand Marais, may be of another geological age or formation.

On the road from Grand Marais to Rove lake there is first a gradual ascent, with some flat spots, to "the summit," which is reached at about 1¾ miles from Grand Marais, where the aneroid shows 785 feet above Lake Superior. There is then an undulating ascent, or flat surface, to near the valley of the stream crossing Sec. 9, T. 61, R. 1 E. when there is a descent of about 40 feet over drift, to the creek, which is by aneroid 838 feet above Lake Superior. The valley here is broad and shallow, without any rock-cut*. The country thence is undulating, with good soil and sub-soil, and rather light timber, to the E. and W. town line, where there is a short swamp, but on the other side of the town line good farming land again returns. The whole distance from Grand Marais, along this road, is a tract generally tillable, even the hillside up which the tract runs. The underlying rock, in the hill seems to be the Palisade rock, probably with igneous rocks in dykes and overflow, but north of the hill the red rock returns again, as may be presumed from the occurrence of loose pieces of the red rock, and its shingle, occasionally on the trail. The rock in actual outcrop is not to be seen on the trail between Grand Marais and the E. and W. town line mentioned.

From the town line north to the Devil's Track river is about a mile. This stream is a little larger than the other, but has a similar valley. There is no rock exposed at the crossing of Mayhew's road to Rove Lake. The valley is in the drift, but most of the stones are from the red formation—either real Palisade rock, or red granite like that seen east of Beaver Bay and at Beaver Bay (V. No. 665).

Along the same road toward Rove Lake, north from the crossing of the Devil's Track river, the red rock continues to form the basis of the country, as shown by the fragments of such rock along the trail, and where trees have been thrown down by wind, to about 1½ miles north of the town line where a belt of coarse dark trap appears, extending perhaps 20 rods, when the red returns for one-fourth mile. Then another belt of coarse trap-rock like that in the Grand Portage region follows for about 20 rods. The general surface is not rough, but undulating. It is covered loosely by a loam, or mold, which supports trees to a certain size. They are generally blown over and afterward consumed by fire which also burns up the soil. There is not much drift.

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*The surveyor's plats here erroneously extend the steep bluffs of rock along both sides of the river.

At the center of T. 62, 1 E. a little knoll of dry land occurs in the midst of a swamp. Here the rock is coarsely crystalline doleryte. At a short distance further an amygdaloid appears, and the "Two Harbor Rock," so-called in these descriptions. This last appears soon after passing a little creek; but the country is in general a swamp, with caribou trail in soft wet moss running among the spruces and tamaracks. The surface is closely underlain by the rock *in situ* or by fragments which are lightly covered by the moss or by a vegetable mold. Among fragments of the "Two Harbor Rock" (and occasionally the rock in place) are to be seen also masses of igneous, coarse-grained rock like that overlying the Two Harbor rock.

642. From about one mile north of the center of T. 62 N. 1 E. on Mayhew's trail. This red rock here which appears as a fine red syenite forms an escarpment about 15 feet high, mostly hid by the trees and moss, facing N. N. E. This is not wholly red within, though it weathers red, but is a reddish-brown, and has red crystalline specks scattered through it. It is in heavy, hard layers, and does not shatter into angular small pieces like the red rock. It contains free quartz. Toward the south the land is higher than this bluff, but the bluff overlooks immediately a swamp, and a creek, toward the north. Toward the west this escarpment rises into a hill 75 or 80 feet high. At the foot of the bluff is the rare feature of a foreign syenite boulder.

643. In the northern tier of sections in T. 62 N. 1 E., where the trail crosses them, is a hill range 100 to 150 feet high, with white pine, birch and white cedar, of larger dimensions than in the lower land. This range is composed of a red rock very much like the last number, approaching the character of the red granite seen east of Beaver Bay (No. 636). Many boulders of such rock are in the road before reaching the hills, and more in ascending them. There are a few also of the gray slate and quartzyte, and some of the Grand Portage igneous rock; nine-tenths of them, however, are of this "red granite."

644. The top of this hill, however, consists of igneous rock. This is not certainly in overflow. It may be as a dyke protruding through

No. 643. East of the Mayhew trail, following the town line between towns 62 and 63, the land rises in a ridge perhaps 200 feet above the country further south. The ridge runs about E. and W. covered with heavy forest, and formed of "red granite." This sample contains quartz and orthoclase, and is not a true igneous rock.

This range of hills, composed of this red rock, appears like a range of upheaval, and finally the country becomes wholly hilly.

645. "Red granite," like 642, from this hill-range, S. W. ¼ Sec. 35, T. 63, 1 E. on a little creek. This rock seems to be the result of higher metamorphism of the coast-line red rock, or the Palisade rock. The change seems to have been gradual. While but little of this rock is encountered along the lake shore, it here constitutes the rock of the country, and rises into considerable hills. This difference of crystallization must be due to greater nearness to the seat of upheaval and heat, which would not be in consonance with the opinion expressed by Messrs. Bell and Logan, locating the belt of greatest disturbance in the bed of Lake Superior. It seems rather to be back in the vein of the lake-basin. Most of the rock is like this number, but there is also much like No. 644, in large masses that fall from the hills, and that lie on the tops of the hills. It is difficult to separate 644 from 645. It seems to be due to a mixed condition of matter from the sedimentary and from the igneous rocks, or perhaps to a complete fusion, and flowing in igneous form, of the same rock.

These hills are from 1,000 to 1,200 feet above Lake Superior, and from 100 to 150 feet above the surrounding country.

646. "Red granite," S. E. cor. T. 63, 1 E.

647. Red rock, like 643 and 645, making hills in N. W. cor. T. 62, 2 E. and N. E. cor. T. 62, 1 E. Associated with this red rock in some way not ascertainable on account of the prevalance of surface mold and bushes, is found the next.

648. This is a darker rock, containing quartz, orthoclase, plagioclase, hornblende, magnetite, viridite, apatite, having somewhat the aspect of the Grand Portage trap hills, but not its mineral composition. It may be only a local irregularity in the lithology, as suggested under No. 645, or due to a profound metamorphism of other sedimentary beds having a different composition originally. There is abundant opportunity for this latter hypothesis, because under the red-rock which is supposed to make by further crystallization the red granite, is an immense thickness of black slates and quartzytes, as seen in the peninsula of Pigeon Point, the strike of which must pass westwardly through the country north of Grand Marais. If the upheaval and metamor-

phism of the red rock, which took place after its deposition, also disturbed with the same long-continued effect the underlying quartzytes, they would be deeply metamorphosed also, and would produce a rock different from a truly igneous rock, and from the overlying red granite. This is also further probable from the observed conformity between the red rock, or red quartzytes at least of Pigeon Point, and the underlying black slates and quartzytes. But at present Nos. 644 and 648, and other rocks like them from the same region, may be conconsidered undetermined, though with a probability of an original sedimentary condition.

649. Sample of the rock seen in loose pieces along the trail going N. between Sec. 36, T. 63. 1 E. and Sec. 31, T. 63, 2 E. A high hill runs along the east of the trail, the trail being west of the town line. This is a red syenite, but with much magnitite and hornblende.

650. Another sample of dark dioritic rock. This is so abundant that it must be in place near, but cannot be seen.

651. Magnetited dioryte, from boulders, seen along the same trail, twenty to thirty rods north of the last. This same rock forms a hill along the right of the trail. This resembles the Herman iron ore (No. 514), but it seems also associated with the dark rock No. 644 and 648, which is regarded as originally a sedimentary rock.

Across the creek which passes north near the town line where this iron occurs, is another hill made of the same rock showing a perpendicular wall facing E. rising about fifty feet, viz.:

652. Dark, heavy dioryte (?) with magnetite, from a point about one-fourth mile from the Brule river, and half a mile west of the town line.

653. Red rock, from the Brule, some west of the town line. This rock still prevails, thrown up by trees.

But immediately across the Brule, on the town line, between it and the head of Elephant lake, is a low range of trap hills, of the kind characteristic of the Grand Portage district. This rock here rises in domes, and the rock it lies on cannot be seen. Yet on the south side of the Brule it apparently lies on the red rock, rising in the hills and ranges higher than this. It is coarse, and not so much magnetited as the rock No. 652, south of the Brule.

North and west of the Brule, the country appears, viewed from a burnt knob of this trap, quite hilly, and apparently the beginning of the broken surface seen along the boundary.

Also west, in the next town, northwest from here, are seen some high hills.

About one-half mile north of the north side of Elephant lake on the town line, large pieces of the slate and quartzyte formation begin to appear, with boulders of the trap last mentioned. The country is more nearly level, but covered with tamarack or spruce in the swamps, and white pine, tamarack, white cedar, poplar, white birch, and mountain ash, on the ridges or higher flats.

A little further on, however, are many pieces of the red rock on the banks of a little creek running west, and as they probably would not have been transported north, but the quartzyte and slate may have been transported south, it is probable that the red rock really extends as far north as this place.

Secs. 18 and 19, T. 63, 2 E, the red rock comes in full force, forming a range of hills running E. and W. across the town line, without a capping of trap. This hill-range is covered with Pinus banksiana, and the ground is carpeted with moss, as in a tamarack swamp. Indeed this carpet of moss is general here. It seems to depend on the rains that are perhaps more frequent about the summits of the hills. The moist winds from the lake encounter the colder land winds coming more from the north, and transient showers are the result.

654. This sample is from a ridge rising about one hundred and seventy-five feet, crossed by the section line running east, S. E. ¼ Sec. 18, T. 63, 2 E. This is plainly an igneous rock of the usual kind seen on the shore of Lake Superior. It is fine-grained and dark.

655. N. E. ¼ Sec. 20, 63, 2. A low ridge of coarse-grained vesicular reddish rock, containing free quartz, probably a condition of the "red rock."

656. At another point, a little further east, this reddish rock vesiccular, and more evidently a condition of metamorphism, not being wholly crystalline.

657. Sec. 16, T. 63, 2 E, (on the southern line, just after the crossing of a creek) is a fine-grained, brown rock, having feldspar crystals handsomely disseminated sparingly through it, and resembling the stellar porphyries, pebbles of which are seen occasionally on the lake shore. It is a dark, brownish rock, which weathers red, but is hard, fine and compact, and shatters under the hammer in memerous preexisting joints which are iron-shot, making sharply angular fragments. This contains fine grains of free quartz, as shown in thin section, and probably comes from the sedimentary beds, associated with the rocks 648, 651 and 652.

658. Further on this ridge takes on the characters of 655 and 656.

659. This rock appears to be in place, but can be seen only in the form of numerous loose pieces. It has the appearance of constituting the top portion of the ridge (658.) It is dark, coarsely crystalline, and allied to the diorytes (Nos. 651 and 652.) This ridge runs E. and W. nearly on the north side of the trail, and rises about two hundred feet.

On the line between Secs. 15 and 22, in town 63, 2 E. the country rock is the "red granite," but there are occasional patches of igneous rock; and also some traces of drift, shown by pieces of the quartzyte and slate, and by occasional boulders of syenite. The surface is generally moss-covered and wet. At the crossing of the Greenwood river, the boulders are nearly all of the "red granite." Following the line further east, to the little lake on Sec. 13, at the crossing of the stream, the rock is of the dioritic kind, coarsely crystalline, but there are a good many boulders of "red granite" and of slate.

At the crossing of the town line, which is on high land, is considerable good pine, perhaps 200,000 per forty on either side of the trail. The rock underlying is—

660. A gray dioryte, porphyritic, belonging to the same class of rocks as 651 and 652. The "red rock" seems to have continued along the line of the trail, as far east as to one-half mile west of the town line. East of that the country seems to have been in the next underlying beds as far as to—

661. One mile east of the town line (S. E. cor. Sec. 18, T. 63, 3 E.) is a reddish crystalline rock in place, and this continues east two miles from the town line.

662. The country seems to have considerable drift, often of clay, and does not show the underlying rock. The surface is nearly flat. This fine-grained porphyry is allied to No. 657 and is from S. W. ¼ Sec. 14.

663. S. W. ¼ Sec. 19, T. 63, 4 E, on McFarland's trail. Here is a short E. and W. ridge, rising about fifteen feet, in which the rock is the stellar porphyry seen in pebbles on the lake shore. It is fine-grained and brown, but is beautifully set with intersecting tabular crystals of flesh-colored feldspar. The mass of the rock is made up of minute tabular crystals of a feldspar and opacite, with a few grains of chlorite, and very rarely a minute grain of quartz.

In about N. E. ¼ Sec. 30, T. 63, 4 E. is another low ridge, but made of a different rock, being of a coarse porphyritic dioryte, like some already numbered.

The height of land back of Horseshoe bay, three and a half miles from Lake Superior is 960 feet above the lake.

664. At a little more than two miles from Horseshoe bay, appears

a diorite rock, in a ridge, made up almost entirely of feldspar and hornblende. A beach line is distinctly marked back of Horseshoe bay fifty feet above Lake Superior.

Passing up the hill back of Grand Marais, on what is known as the "Iron Trail," the hill is found by aneroid to be 1,063 feet where the trail passes over it, or 278 feet higher than where the Rove lake trail passes the summit. This is about one and one-half miles from the lake shore. The surface descends eighty-seven feet in passing northward to the level of the water in the south branch of the Devil's Track river.

The rock is mostly hid on this hill by drift, some of it being clay on the top, but in the southward slope, where the face is most precipitious, the rock is exposed.

665. Rock from the Grand Marais hill, eight hundred feet above Lake Superior, having a face seventy-five feet high toward the south. Rather fine-grained trap, reddish brown, evidently an igneous rock. The top of this hill seems to consist of this rock, but toward the base, on the south side, the red rock that forms the beach at Grand Marais is so abundant in old tree-roots, thrown up by the wind, that it is unquestionably in place there, though so covered by its own debris that it cannot be seen *in situ*.

The level of the general surface does not fall away again, after reaching the top of the hill, more than thirty or forty feet, when it becomes a swamp of spruce and tamarack, with the usual covering of coarse Caribon mosses. Passing over the swamp, (about three-fourths of a mile) a slight ascent begins, rising again to about the level of the first hill. After a short distance of dry land the surface descends rather abruptly to the south beach of the Devil's Track river, which is eighty-seven feet lower than the top of Mayhew's hill. No more rock is seen to this place, and here can be seen only boulders. The lake from which the south beach flows is thirty-nine feet higher than the river where the trail crosses it.

666. "Red rock," with small glassy crystals like quartz, from the N. E. side of the lake from which the south beach of the Devil's Track flows. Many loose pieces are seen, but none is to be seen in place, the country being drift-covered. Devil's Track lake is forty-nine feet above South Branch lake, or 1,064 feet above Lake Superior. No rock *in situ* appears between the perpendicular escarpment of the Grand Marais hill and Devil's Track lake, so far as can be seen along the "Iron Trail," which strikes the lake on the south shore one-fourth

mile east of the fourth meridian. The beach here shows no rock, *in situ*, but is composed entirely of small augular pieces of—

667, which is evidently the rock of the country, on account of its abundance, and the fresh angles of the outside. It is reddish-brown, compact, rather fine-grained, but porphyritic with flesh-red feldspar of the color of the moss. In the interior are seen, on fracture, green specks probably due to changed hornblende. On the surface these weather out. making a pitted exterior. It also contains free quartz, making it the equivalent of the red syenite associated with No. 1 at Duluth.

The divide N. of Devil's Track lake is 1167 feet above Lake Superior. The swamp, which is one and one-fourth miles on the portage from Devil's Track lake to Tamarack lake is 1152 feet above Lake Superior. About one-half mile N. of Devil's Track lake the trail crosses the fourth meridian, and continues in a general N. N. W. direction to Tamarack lake. The country about is not hilly, but rises perhaps thirty or fifty feet above these lakes. Tamarack lake is 1132 feet over Lake Superior. The Devil's Track rivers enters it from the N. E. and a short distance above the lake the country becomes a vast swamp of tamarack and spruce. In the swamp are occasional dry knolls of gravelly clay and waterworn drift, but in general throughout the swamp the surface is covered with a thick coating of different caribon mosses. The knolls sometimes spread out indefinitely, rising four or five feet above the swamp, making a small flat area of the same characters as the knolls. There is no rock in place. The country is covered with drift. These knolls are of drift.

The agricultural character and value of this swamp are likely to be mistaken. It seems that in all parts of this district, wherever the surface is nearly flat, and the nature of the underlying rock is not such as to allow easy and rapid escape of the surface waters, a swamp of tamarack and spruce (or perhaps in a stony area, of white cedar) inevitably supervenes; the easily drained hilly tracts, which perhaps are so stony and rocky as not to be arable, are *apparently* better for farming, and are now covered with fine timber. A settler would naturally select these uplands, whereas really the low lands are furnished with the better soil, and are freer from stones. This covering of the uplands with a more or less hardy and stunted evergreen forest, somewhat sparse, is characteristic of high northern latitudes, and here seems to be due to the severe, but moist climate which prevails.

Owl lake is about twelve feet higher than Devil's Track lake, or 1,148 above Lake Superior.

668. About one-third way across the portage from Owl lake to Little Pine lake, are low rocky mounds and ridges, twenty-five to sixty feet high, covered with pine. These ridges consist of this rock, a red syenite, with green specks and red feldspathic crystalline surfaces like several other samples obtained in this region.

The kind of country described north of Tamarack Lake, does not continue through to Little Pine Lake, but in a short distance lindens appear in the forest, then white pine, hazel, mountain ash, &c., while tamarack and spruce gradually disappear, the balance continuing to be interspersed even among the pines and in the uplands. Pretty soon the forest is nine-tenths white pine, the rest being composed of white birch, Norway pine, balsam, Mountain ash and Mountain maple, at the same time that the level of the country is elevated to 100 and 150 feet above the adjoining lakes, and is rolling and hilly, with frequent large boulders and occasional exposures of the underlying rock (668). The soil is coarse and stony, with boulders of light syenite and many of red syenite from the rock of the country. It is a rusty, loamy clay, that seems to be the direct result of the disintegration of the stones of the drift, changed by the action of vegetation.

669. Is from what appears to be a dyke, about half way between Owl Lake and Little Pine Lake, though the exposure is not sufficient to show whether a dyke or not. There is a perpendicular wall exposed, running N. and S. near the trail, on the east side, extending about 25 feet and rising five feet, sinking down to the general level on either side, facing west. There is in it a jointage that weathers out in perpendicular bands or basaltic layers, that run E. and W. from one inch to three or four inches in thickness, very much like dykes seen on the shore of Lake Superior. There is also a blind ridge or elevation running east, through the woods, of about the same height, but showing no rock as far as traced. Toward the west, after a low gap of about 40 feet, the surface rises gradually to about eight feet, and in the top is the same rock; but it abruptly sinks away into a valley, while toward the N. W. is a considerable elevation or ridge covered with pine and containing the red granite No. 668. No. 669 seems to be a dyke cutting the red rock, and perhaps breaking through it in a number of other places. It is, indeed, one of the causes of the "red granite" which all of the time is supposed to be due to complete fusion and change of the "Palisade rock," and that to a feebler application of the same force to the red shales and sands of the Potsdam seen in the St. Louis river at Fond du Lac. No. 669 is apparently what Prof. Pumpelly has described as a *melaphyr*—a dark homogeneous trap,

globuliferous-weathering, and sometimes showing in the sunlight large reflecting crystalline surfaces in the mass of the rock, due to crystals of pyroxene that embrace all the other minerals.

A short distance north of the divide between Owl and Little Pine Lakes, on the north slope, the red rock, which is laid bare by the overthrow of a large pine by a late cyclone, shows a smooth glaciation, but no prevailing direction can be distinguished.

Little Pine Lake, which is 1,154 feet above Lake Superior by rough aneroid observations, has no rock visible about its shores, but under the water near the shore can be seen everywhere sub-angular pieces of the red syenite like No. 668. In making the portage from Little Pine Lake to Clubfoot Lake, which is 1,173 feet above Lake Superior, there is a small exposure of the red granite seen on the trail, but elsewhere the rock is either hid, or is of boulders. About the S. and W. end of Little Pine Lake are numerous foreign boulders. The same is true of the S. and E. shores of Clubfoot Lake.

Round Lake is 1,208 feet above Lake Superior, and Abita Lake is 1,349 feet.

670. From one-fouth mile S. of Lake Abita, in the large hill over which the trail passes, apparently a dioryte, consisting largely of hornblende.

671. "Red granite," from the hill near the south shore of Lake Abita, but not certainly in place. The hill rises about 225 feet above Lake Abita and 1,574 feet above Lake Superior, and is separated from the hill from which No. 670 comes by a dry valley, but which has a creek in wet seasons.

672. The same hill which furnishes No. 671 near the lake is made up of this rock toward the top, being a coarse dioryte. In what manner this is related to No. 671 does not readily appear. There can be seen large blocks of this, and some small mural faces, along the north side of the hill, but in general everything is hid by turf, forest and mosses. There is but little doubt, however, but these blocks are not far removed from their natural places.

The lakes of Brulé river, north from Brulé Mt., are 955 feet above Lake Superior, by aneroid, and Brulé Mt. in its highest part is 1,461 feet above Lake Superior. Brulé Mt. does not appear like a mountain from the south, rising but 30 feet above Lake Abita, but from the north it is very prominent as an isolated hill that rises 506 feet above the river flowing along its northern base.

673. "Red granite," top of Brulé Mt. and the rock is not well seen

in situ. Almost no rock but the red granite is seen along the trail from Lake Abita to—

674, a rather fine-grained deposit, with quartz, which occurs on the north face of Brulé Mt., forming a perpendicular wall about 20 feet high, but is only seen (so far as examined) a little east of but near the trail. It is 240 feet below the top of the mountain, and makes a more or less continuous jog or shoulder. Very few red pieces are to be seen north of this shoulder, but south of it they make nine-tenths of all the stones. Occasionally light-colored gneiss and granite are seen, and rarely a piece of siliceous slate, so that it seems as if here were the northern boundary of the red granite (V. No. 685).

675. In the northern face of Brulé Mt., 300 feet below the top about south from the east end of the westerly lake in Brulé river. This reddish granitoid rock forms a perpendicular wall of 60 feet in height. This contains much hornblende, thus causing it to approach the mineral characters of the dioryte No. 674.

676. At a lower level another perpendicular wall of rock is found on the north side, a little to the west of the section line between sections 16 and 17, rising about 78 feet. This rock resembles the rock No. 674, but the bluff cannot be said to consist entirely of this. Another exposure of rock like No. 676 is at the water level, on the north side of the lake mentioned. It runs under the lake, sloping south, and is, like No. 676, deeply disintegrated.

The top of Brulé Mt. is rounded and forest-covered, the ascent in all directions being very gradual, but most abrupt from the north. The only rock seen is boulders, generally of dioryte. The highest point is about one-eight mile east of the section corner (17, 16, 20, 21, in T. 63 N. R. 1 W.) and one-sixteenth of a mile south. From this place no higher land can be seen toward the east, but there is a high peak toward the S. W. six or eight miles, supposed to be Eagle Mt., a very high range visible a few miles north, afterward learned to be the *Misquah Hills*, and other hills to the west. About north of the peak thought to be Eagle Mt., is a high square-cut hill, like one of the Sawteeth hills; but toward the S. E. is low, flat ground, probably the course of the Brulé valley*.

On the next portage northward from the Brulé river the country is a swamp, with occasional low knolls, or short ridges, the whole covered with tamarack and spruce, and the lower parts being very stony, similar to the St. Louis valley from N. Pacific Junction northward to

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*Some of these particulars were obtained of my man Mallmann who climbed a "Jack pine" eighty feet high, growing on the top of the mountain, and from it described the surrounding country.

Knife Falls, and similar to many swamps in this northern part of the State, the most of the stones here being of the rock No. 676, but with a sprinkling of red granite, as if there were still rock of that kind in place further north. Some of the boulders are banded with magnetite. At about half way to Little Trout Lake the boulders of red granite constitute about half of all.

677. A short distance further north a hill rises on the east of the trail. but near it, (about 100 feet), consisting of the rock of this number—a very fine-grained basalt, nearly black, compact. In thin section this shows a multitude of similar polarizing, rounded small crystalline grains dispersed through a ground-mass of uniform character that is apparently semi-crystalline with scattered cubes of magnetite. This would seem to make it a crysolite basalt.

But in following the trail it passes over this hill-range, which is only part of a generally hilly tract surrounding the Little lake, next on the trail, the lake itself being 244 feet above the Brule river. These hills are not large, rising about 200 feet, but the country is what may be styled hilly. The rock constituting them is of the same kind as No. 676, and of the "red granite;" large masses of the former, and many small pieces of the latter, being strewn about.

This hill extends to the Little lake, and along the S. E side, where the superposition of the strata can be made out in descending order, the highest stratum being of the "red granite." Thus: (with a dip 10 deg S W.)

Red granite (not actually seen in place.)	
No. 678, in a regular bed of the thickness of.........	15 ft.
No. 676, porphyry with red feldspar.................	4 ft.
No. 679A. porphyry with gray feldspar...............	8 ft.
No 680. Fine bedded, crumbling, seen.............	18 ft.

The foregoing does not include all the strata, some being invisible both at the top and at the bottom. These strata seem to belong to the formation of the great slate and quartzyte range, underlying the cupiferous, as developed at Grand Portage and along the boundary line, but here more metamorphosed.

678, is a dark (pyroxenic ?) rock, with no apparent feldspar. Fragments of a rock like this were seen on the top of Brulé Mt , evidently carried there by the drift movements, and could not be referred to their stratigraphic position. (V. 684)

679. Finely porphyritic with red feldspar, the ground mass being like the rock No. 678.

679A. The same as the last, with gray feldspar crystals.

680. A fine-grained, dark rock porphyroidally sprinked with feldspar of a flesh-red color. While this is in heavy beds in the stratification, it has a fine, rudely basaltic, disintegration, due to a structure of short joints and cross-planes, mainly perpendicular to the dip, by which it crumbles out so rapidly that it is not easy to get a fresh fracture. It is one of the shaly sedimentary parts of the so-called Animikie Group.

Little lake is 1,199 feet above Lake Superior, and about 200 feet below the surrounding hills. Little Trout lake is 1,272 feet above Lake Superior, being the highest on the Iron Trail in the traverse from Lake Superior to the boundary line.

The hill at the right of the portage from Little lake to Little Trout lake is made up of the numbers 681, 682 and 683 is downward order, with the thickness stated below: dip 20° S. E.

681, (seen twenty feet, may have more above.) A very fine, black rock, approaching aphanitic slate.

682, (35 feet) Porphyry, both with red and with gray feldspar crystals. This is a part of the great formation lying below the cupriferous, already mentioned, and is in beds of an inch, where weathered, or in heavy layers of five or six feet. The ground mass seems to be the rock No. 678. The red color seems to come from weathering, the original color being gray. This is shown in one of the small samples. It has free quartz.

683. (20 feet; there is a talus below of fifty feet in which the rock is unknown.) A fine-grained heavy dark rock, apparently consisting of triclinic feldspar and diallage with a little uralite and magnetite.

684. Further north is a layer of four feet of a fine black rock, evidently crystalline, somewhat like No. 678 or 683, included between some of the beds of the foregoing porphyry, near the bottom of the same.

From Little Trout lake to Misquah lake is a descent of fifteen feet.

685. Reddish-brown rock weathering red, with red feldspar crystals. This rock makes the Misquah Hills in the S. W. part of T. 64, 1 W. It is rudely and coarsely basaltic, the columns being perpendicular to a S. or S. E. dip. This number is from near the trail about a mile south of Misquah lake, near the town line between 63 and 64, on Sec. 32, where a thickness of fifty feet can be seen. It is bedded as well as basaltic, and in weathering sometimes shows laminae of one-fourth and one-half inch. It is undistinguishable from the rock frequently called red granite in these descriptions, but its geographical position seems to place it in a lower horizon. There may, however,

be several faulted upheavals of the same horizon, so that in going north one does not invariably pass on to lower beds, but sometimes from lower to higher.

Misquah lake* is flanked on the N.E. and E. by high brick-red hills. Some of them being 500 or 600 feet high. The trees, being nearly all fire-killed, and even consumed, allow a perfect view of the rock. It is the same as 685.

686. "Red granite" from the east of Misquah lake, Sec. 32, T. 64, 1 W. This rock is basaltified and massive, rising in mountain-like masses. It dips at a high angle toward the east.

687. The same rock as the last, brecciated or scorified, though still weathering brick-red.

These mountains are mainly to the east of the trail and so far as can be seen they are formed wholly of this red rock.

There is much drift in the form of large boulders along the lakeward side of these red hills, particularly near the lake where the trail goes. These large pieces are of dioryte, often magnetited, and porphyry like No. 682, or dark rock like 681, with many pieces of siliceous slate and gray quartzyte.

688. The character of the rock, and of the country, changes at once on entering Cross lake, which is thirty feet below Misquah lake. The rock when first seen is at the right of the entrance, and is mixed and irregular in structure, as if it had been a conglomerate originally. In general it is porphyritic with gray feldspar and has a little quartz, but the ground-mass, which seems to be the rock No. 678, varies greatly in its prevalence over the feldspar—also the size of the feldspar crystals varies. Hence the outward aspect of the weathered surface is spotted with dark and light colors, the feldspathic parts (and particularly the coarser-grained) becoming white, or nearly so, the rest being darker, or with fine mixture of dark and light. This rock has a basaltic structure, and a very heavy bedding, the latter dipping south, and the basaltic structure being perpendicular to the dip. (V. 701 and 702.)

Cross lake is a large lake, expanding in finger-shaped elongations east, west and southwest, and having several rock islands, as well as north and south. This lake and Misquah lake are tributary to the North Brulé river. The shores and the islands of Cross lake are low, made of the next numbered rock.

689. Similar to No. 688, but more uniform in structure. Evidently a gray dioryte, from the same formation as that, and much like the rock 682.

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*So called from the Chippewa word meaning *red*, in allusion to the red walls by which it is enclosed along its east shores.

The lake through which the North Brulé flows, next north of Cross lake, is surrounded by a similar low country, and has the same rock as No. 689. This also has many arms and bays running west, and from one of them is a canoe trail and portage to "Brulé river lake," which gives source to the South Brulé and to Temperance rivers.

Cariboo lake is 1,238 feet above Lake Superior, and twenty-two feet higher than North Brulé lake. Its shores are low, mainly of bare rock like 689, which however, rises in some places from ten to fifteen feet. The timber is fire-killed, or consists of a second growth of small trees ten to twenty feet high. Between this and Poplar lake is Little lake, three feet higher than Cariboo lake.

690. Near Little lake, at the north end of the portage, is a bare dome of rock, rising in the swamp about twenty feet, represented by this number. It is dark-colored, hard and fine-grained. It is not bedded, nor visibly basaltic, but all over the rounded exterior are polygonal spaces, marked out and included by bands of harder rock that rise as low ridges above the surface, fitting exactly to each other. This rock under the microscope shows its igneous origin by its composition which is plagioclase, augite and magnetite. It also seems to hold an occasional grain of quartz.

691. Gabbro, consisting of plagioclase (assumed to be labradorite), diallage and magnetite; related to the last. This is a sample of the usual "trap" of the country. It weathers light, and is in that way in marked contrast with the last, though that difference seems to be due solely to the greater proportionate amount of feldspar in this, and of augite in that. This occurs in patches on and in the last, and especially on the north side. It also seems to cross and cut it in vanishing veins.

692. Gabbro, like the last; this forms a series of bluffs along the south shore of Little lake, of about the same hight and form as the last described, but the rock is rather finer-grained than much of the trap of the country. This makes a low hill-range along the south side of the lake.

Poplar lake is 1,221 feet above Lake Superior. The rock the whole length of Poplar lake is the same as 692.

693. Gabbro; from the west end of Poplar lake, where the portage trail leaves it going to Duck lake. It rises about twenty feet above the water all about, in undulating domes, rounded as by glaciation, though no glacial marks can be seen. The country is burnt; a few foreign boulders are strewn over the bare rock surfaces.

Duck lake, by aneroid, is found to be 1,244 feet above Lake Superior, and Portage lake 1,234 feet. Where the trail reaches Portage lake is a low upheaval of rock like No. 693. The country generally is made of this rock, nearly bare. It contains in some places considerable magnetite. Mayhew lake is 1,213 feet above Lake Superior.

The same rock as 693, or some slight variation from it, continues to the entrance on Mayhew lake (or Iron lake), with increasing frequency of drift pieces of flinty quartzyte and slaty quartzyte. The trap is more magnetited in places, but, except in that particular no change can be seen.

694. Gabbro, with much magnetite; a little east of the section line, between sections 32 and 33, on the south shore of Mayhew lake (or Iron lake.) The rock here is in even and continuous beds, that dip regularly to the south, like the quartzyte and trap of the country, undulating a little up and down. This is seen in many places. It occurs also on the south shore of Portage lake. The beds vary from four inches to twelve inches in thickness, and show weather-stripes on the exterior, due to varying composition, something like a sedimentary rock. (V. No. 814.) They suggest the query whether this trap may not be due to a change, *in loco*, of the early sedimentary rocks. The great extent, the constant dip, and this regularity of bedding, and its thinness, all coincide to point to that as its origin, rather than to the overflow of molten matter over so extensive a region. The mineral composition, however, is constant, and allies it to the igneous rocks of the "gabbro range" which graduate into the trap rocks of the Cupriferous. It seems, however, that there was a vast outflow of igneous rock in the midst of the era of the quartzyte and slate group, producing this area of the "gabbro range," and separating the lower portion from the eras of the porphyries, and the red shale and red sandstone which are characteristic of the cupriferous formation proper. There are some reasons for believing that this great igneous outflow entered the sedimentaries as "laccolites" in many places, and thus tilted and modified the overlying beds, instead of being produced prior to their deposition.

695. Magnetic ore, S. E. ¼ Sec. 36, T. 65, R. 3 W. on the north shore of Mayhew lake (also known as Iron lake.) This rock is a condition of the trap of the country, and is almost entirely made up of magnetite. A careful study of this location warrants the following generalized statements:

(1st.) The ore is in the igneous rock.

(2nd.) It varies in quality very much, even passing into rock that cannot be styled iron ore.

(3rd.) It involves with itself nodules of coarse gabbro containing considerable magnetite.

696. Sample of this nodular or concretionary rock embraced in the iron ore.

(4th.) It also embraces isolated pieces of gray quartzyte (apparently), but which in thin section are seen to consist of plagioclase, magnetite and augite; and some dark, crystalline, micaceous nodules.

697. Samples of the dark and micaceous nodules. These dark masses embrace dark labradorite (?) biotite, hæmatite, with viridite.

698. Samples of what appears like a granular, gray quartzyte, but which really consists of the minerals that go to make gabbro. This is distributed through 695 in rounded lumps like some masses of No. 696. Some masses of No. 698 are very large, where they occur on the north side of the swamp.

(5th.) It dips toward the south in beds whose aggregate thickness is at least fifty feet, but may be seventy-five feet, the actual amount being hid by a swamp.

(6th.) It involves also detached masses of coarsely crystalline gabbro nearly free from magnetite, but containing biotite.

(7th.) It sometimes gives place to a coarse trap of the same kind which is so large in amount as to constitute the rock of the place, and its connection with the ore cannot be seen.

699. Samples of this coarse, micaceous trap.

(8th.) It lies on a fine-grained rock like No. 698, which is a fine gabbro with chrysolite, resembling a fine, granular, gray quartzyte. This rock dips, so far as any dip is discoverable toward the north, and it seems to have furnished the rounded masses of No. 698 embraced in the iron ore. The northward dip is due to a deceptive appearance of columns of basalt.

700. Samples of this fine chrysolitic gabbro. This rock much resembles the chryrolite basalt No. 677.

(9th.) In seams and gashes in No. 698, the rock No. 699 is also found.

(10th.) The iron in considerable, but unknown quantity, is of fine quality, being seen in other places besides this described.[*]

West from this iron location, after passing the little bay running E. N. E. the north shore of the lake is made up of No. 699, which appears massive, weathers lighter than the trap usual in the country, and appears like the "Rice Point Granite." It is hard and firm, and rises in domes which rarely show any dip. At one-fourth mile west of the little bay it is broken by the lake and ice in winter and over a small area shows both a horizontal jointage, and one which has more the characters of dip to the N. 45 degrees—the latter having the planes of separation at varying intervals of six to eighteen inches, and marked also by a lighter weathering, or by a pinkish stain in the feldspar. This, however, may be the remains of a former basaltic structure.

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[*] This iron ore constitutes what is locally known as the "Mayhew Iron Range," and is found in a belt about a mile wide on both sides of Iron lake, and on the south side of Portage lake, and between Portage and Poplar lakes. An analysis reported by Mr. Hause, performed by R. S. Robertson of Pittsburg, Pa., gave the following result: Silica, 2 02; Alumina, 2.68; Titanium, 12.09; Sesqui Chromium, 2.40; Mag. ox. Iron, 80.78; Lime, trace, phos. acid, 0.03.

701. .The rock last mentioned, resembling the "Rice Point Granite." It consists largely of a gray feldspar, is firm and massive and rounded. It also has diallage and magnetite, with occasional scales of biotite.

702 is embraced in pockets and lumps in No. 701. It is the same rock, but with much coarser crystals, and a larger per cent. of diallage (V. No. 688 and No. 1 D.).

703. Sample of iron ore at the east end of Pewabic Island containing all the ingredients of the rock, even mica. There are three or four other islands in the west end of Iron Lake. The iron here is plainly embraced in the rock 701, which is also the same as No. 696; which is the same as the rock styled trap or gabbro all the way from the south side of Little Lake. This rock of course has variations which account for its different aspects, but in all these it does not depart from the accepted characteristics of an igneous rock. Its variations are included within the range of mineral associations possible, by relative changes, in plagioclase (probably labradorite), chrysolite, augite, magnetite and it has as accessories biotite, hæmatite and a green mineral that may be derived from a decomposition of the augite. which is also frequently in the condition of diallage.

About a mile west of the end of Mayhew Lake, on the town line, is an isolated knob of the same kind of iron ore, in low ground, "30 links wide, all solid iron," so reported by Paul Morrison.

704. South of the little island crossed by the E. and W. town line, in Mayhew Lake, the rock is highly magnetited. It is also micaceous. It has plainly a dip to the south of about 25°. The jointage here is also somewhat like the apparent dip seen on the north shore four miles west of the little bay. A similar deceptive jointage resembling a N. dip is to be seen at the portage to Loon Lake, the general dip being to the south.

705. Appears like a metamorphic rock, bedded and dipping north about 45° at a point a little back (N.) from the shore, a short distance west of Mayhew's location, which underlies the iron-bearing rock, and the iron ore, and has been styled changed quartzyte. It really is a

crystalline, fine-grained rock which has hornblende changed to viridite, feldspar and magnetite, and its apparent northward dip is due to a fine basaltic jointage perpendicular to the true dip, which is about the same in degree toward the south (V. No. 700). No. 705 has a visible thickness of 10 feet, and the overlying iron rock has a thickness of about 20 feet.

706. Through the iron-rock at the location 705 run seams, three to six inches in thickness, of pinkish rock consisting of quartz, orthoclase and hornblende, in rather fine grains. These seams and veins are parallel with the basaltic jointage of the rock No. 705. Sometimes a pinkish shade of color runs into the trap, accompanied by quartz. These pinkish beds and seams, which simulate planes of bedding are probably due to contact with the underlying formation and nfusion from it.

707. In some places in the trap, where one of these red seams passes through it, the hornblende which accompanies the red rock, greatly predominates, or is very coarse, and sometimes is fibrous and radiating, coating the walls of the seam. In such places mica also can be seen, and also, mixed with the fibrous hornblende, occasionally a crystal of quartz.

Nearly everywhere about the shores of Mayhew Lake the rock is trap, or gabbro, but generally with more magetite than usual.

708. On the portage north from Mayhew Lake to Loon Lake, the rock No. 705 first appears, with a southerly dip. Then, after a low space another ridge succeeds, showing the rock No.708, similar, if not identical with No. 705. This belongs to the great quartzyte and slate formation, or the "Animiki group." From the top of this ridge the descent to Loon Lake is sudden, and amounts to 150 or 175 feet.

709. This is a range of high hills along the south side of Loon Lake, and between the bay and the lake, the top of which are made up of rock of this sample, which is like No. 708, having a thickness of 80 to 90 feet. This has the outward aspect of trap and perhaps has been designated trap in former instances, but it is to be distinguished from the igneous rock that has been described. Under the microscope in thin-section it consists of a triclinic feldspar, and some orthoclase, changed (or viriditic) hornblende, magnetite, and a small amount of quartz—a kind of dioryte. Its affinities with the great quartzyte and slate formation are evident, and it seems to have resulted from a metamorphism of the upper part of that formation. It is that which underlies the iron-bearing trap of Mayhew Lake. It is in heavy layers 4 to 10 feet thick, and has a coarse, perpendicular jointage that makes it

appear basaltic. It stands in perpendicular escarpment facing north and west, making the tops of the highest hills. It probably has not everywhere been kept distinct from the true igneous rock or gabbro which constitutes a heavy stratum lying over it. (V. under No. 300.) This is taken from the hill near the base of the point separating the bay from Loon Lake.

710. Dark, homogeneous, finely crystalline, heavy rock like No. 684, underlying No. 709 in the same bluff, 5 to 10 feet in thickness. This is in beds 6 to 10 inches thick.

711 and 712. The rest of this hill is made up of alternations of these rocks, altogether making a thickness of 100 to 125 feet, down to the level of Loon Lake. The former constitutes about nine-tenths of the whole. It is black, and grayish-black, in beds from 4 to 40 inches, very fine-grained, sub-crystalline, with a felted polarization, having a conchoidal structure. The latter is of the same color but more coarsely granular, is in beds of 1 to 3 inches, and is slaty in the direction of the dip, which is S. and 10° to 15° in amount, but in other places the dip amounts to 20 degrees. This hill is only one of a series of northward-facing bluffs which extend from some point in Canada as far west at least as the west end of Gunflint Lake, and produce a sudden shoulder in the surface contour. The actual highest divide, or *Mesabi* is usually a few miles further south, and is apt to consist of the gabbro rock. While there is a sudden descent northward from the face of these bluffs, amounting to 300 or 500 feet, the general level toward the south ascends to the top of the Mesabi, though sometimes there are two or three interrupted lines of similar northward-facing hills before the Mesabi is reached.

The country along the north of Tucker Lake is low, and occupied with magnetited trap, and this character continues southwestwardly some five or six miles further.

713. From the north shore of Tucker Lake, a magnetited gabbro, embracing also masses of rock like No. 702.

On the south side of Tucker Lake is a long range of hills rising about 100 feet, constituting the red Mesabi, though the whole tract between Tucker and Loon Lakes is also on the height of land for this region.

714. Gabbro from the hill range south of Tucker Lake, in the N. part of Sec. 10, T. 64, 3 W.; being the Mesabi in this part of the State. This is the same rock already described as constituting the low shores of Poplar and Iron Lakes (Nos. 693, 694 and 701). Between this hill range and Tucker Lake are several lower ridges of trap

rock. South from Iron Lake the "red rock" begins again in about six miles, according to Paul Morrison.

Duck Lake is 1,244 feet above Lake Superior. Poplar Lake, which is large and long E. and W., has numerous islands, resembling Saganaga, except that here they are of diroyte and gabbro instead of granite

715. From an island in Poplar Lake, near the portage coming from Little Lake. The usual rock about Poplar Lake.

Hungry Jack Lake is 1,069 feet above Lake Superior by this series of aneroid connections Last year this lake was ascertained to be 1,200 feet above Lake Superior by series of observations from Grand Portage, making a disagreement of 131 feet (see the ninth annual report, p. 78, where this lake is distinguished as a "lake south of Birch Lake"). If this is all due to erroneous observations of the Iron trail south from Grand Marais, the elevations given along that route should be increased somewhat. The error is more likely to be in that route than in the boundary line route.*

716. Trap-rock, from the top of the "stair portage" which connects Duncan's Lake with Mud Lake. This forms a high basaltic bluff facing north, a little west of the portage.

717. Trap-rock from the north side of South Lake, opposite the town line between ranges 1 and 2 west. The north shore of this lake is low, and glaciated S. W. and N. E., and the south shore rises into high hills containing, presumably, the rock No. 716, at the top.

718. Fine trap-rock, south side of Gunflint river, a little east of the location of No. 305 last year. This runs obliquely down to the river, and under the water, in angular basaltic blocks like trap, presenting a face (back in the woods) toward the north much the same as the highest bluffs of the country.

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*Mr. E. Le M. Hoare carried a series of aneroid elevations from Grand Marais to Iron Lake for railroad purposes, and found the highest point on the line to be 1.180 feet. His route is shown on Plate II. This height was reached in S. W. ¼ Sec. 25. T. 63, north of the Twin Lakes From that point there is a very gentle, undulating descent to Iron Lake, along his route, which was found to be about 1.175 feet above Lake Superior, or 38 feet lower than by the observations of the geological survey His profile shows a nearly level grade from the highest point southward to a point about a mile and a half north of the Devil's Track river, where a descent begins. The crossing of the Devil's Track river is 1.015 feet above Lake Superior. For the next two miles and a half the descent is 150 feet per mile. Between two and a half and four and a quarter miles from Lake Superior the grade is 165 feet per mile. and below that it is 147 feet per mile. The crossing of the South branch of the Devil's Track river is 655 feet above Lake Superior By spirit-level and rod a point was fixed on the S. E. ¼ Sec. 13, T. 61 N., at the crossing of the creek, which had an elevation of 1,080 feet, and by the same means Devil's Track Lake was found to be 1,025 feet, or 39 feet lower than by the observations of the geological survey. Mr Hoare states that numerous magnetite boulders are scattered over the country between Grand Marais and Iron Lake which produce marked local disturbances of the needle, and that there is evidently a deposit of iron ore at some point between Sec 6, 61, 1 E., and Devil's Track Lake. From several assays Mr. Hoare states that he ascertained the iron and titanium together in the ore from Iron Lake to be pretty nearly uniform throughout. but that the titanium varied from 6 to 13 per cent . displacing about the same percentage of iron. The ore is in enormous quantities, in one place laid bare so that he crossed over it 30 paces. Another deposit of magnetic Iron was assayed by him, located "close to Poplar river and near Lake Superior," which produced 38 p. c iron, 1.53 p. c. manganese, and .05 of phosphorus

719. Trap-rock, having a jointed, or basaltic structure, from the easterly of the two points that enclose the little bay on the south side of Gunflint Lake into which the portage comes from Loon Lake. This point rises about 75 feet. The top, represented by this rock, containing augite, plagioclase, magnetite and a little hornblende and quartz, is of the rock that usually forms the tops of the high mono-clinals of the country—a dioryte trap, perhaps a metamorphic condition of the beds of the great quartzyte and slate formation. It faces the lake and has a high talus of fallen blocks.

720. The rock of the westerly of these points, almost identical with No. 718, essentially the same rock as 719, presenting a walled face toward the north, much jointed, or finely basaltic, rather finely crystalline, but rising but 10 feet above the lake. Thus it appears to make no difference at what horizon samples are taken from the "quartzyte" formation, if they only come from the *top beds* at the place they are obtained. They are always "changed quartzyte," or trap, so-called. Slate can be got only at a depth of 75 to 100 feet below the top. It seems as if any and all the beds are subject to this metamorphism when they happen to be superficial, unless these be unknown and unsuspected irregularities in the stratification. Hence, even at the very northern edge of the area covered by these mono-clinals, the changed rock, or trap, whichever it be, lies within a few rods of, and nearly on the same level as the talcose slate and syenite, as along Gunflint river.

721. A careful section of the hill was taken, lying a little east of the portage trail from Gunflint Lake to Loon Lake, on Sec. 26, T. 65, 3 W., for the purpose of ascertaining what relation might exist between the basaltic beds which always lie on the tops of these hills and the slaty layers that compose them toward the bottom, with the following result: No. 721, forming the top of the hill is 75 feet thick, and like numerous other samples already noted, viz., Nos. 308, 705, 708, 709, 719 and 720. The hill is 250 feet high.

722. Obtained about half way down the perpendicular portion of the bluff. The same as the last, but finer-grained. It has also a darker color. It embraces apparently triclinic feldspar, magnetite, orthoclase, viridite and a little quartz. It also shows an occasional grain of pyrite and of dichroic hornblende.

723. A dark, or gray, homogeneous rock, in general character similar to the last, though of a finer grain, resembling very much the rock No. 683. It has pyrite, and much of the magnetite is arranged in branching, foliage-like tufts, which can be seen in a thin section, from near the bottom of the perpendicular part.

724. One foot lower in the bluff than the last. Undistinguishable from the last.

725. Six inches lower; same rock but finer. This is hard, fine, dark-colored.

726. A foot lower; the same rock but finer, and tending to a slatiness.

727. Four feet lower; slate, fine, black or nearly black, of the kind commonly seen in these bluffs. The rest of the bluff is much hid by talus, but so far as can be determined consists of rock like 727. A hundred feet lower, and but a short distance north from the foot of this bluff was obtained No. 720, forming the top of a lower ridge of rock.

The transition from the basaltic rock, or trap, forming the top of this hill (No. 721) to the slate of No. 727, is more abrupt than on the south side of Loon lake: but there is still here an imperceptible transition. There is no suddenness about the change, nor break in the bedding to indicate the former fluidity of the top of the hill. The change is complete in the space of four feet—from basaltic columnar structure to perfect, horizontal, or southward dipping slatiness. If the basaltic portion is due to igneous origin there was such a transfusion of mineral characters, and such a perfect cementation between it and the slaty portion that no line of separation where the igneous portion was superimposed on the sedimentary, can be designated.

A second visit was made to the locality No. 312, on the north side of Gunflint lake, where the flint beds appear in outcrop, about half a mile east of the outlet of the lake, at which the following conclusions were reached:

1st. The rock is a breccia in which the flint, generally black, or dark jasperoid, appears in a gray rock which weathers rusty, in angular pieces of all sizes up to two feet, or even makes continuous beds more or less tilted and broken. Sometimes also the gray rock that weathers to a rusty color on the beach is in angular pieces or patches in a mass of angular pieces of non-rusty gray rock; and sometimes the two alternate in parallel bands as if so deposited as sedimentary beds at first.

2nd. The formation, as it is, is tilted into the lake, southward, at an angle of perhaps ten degrees, on an average, though there are places where the dark jasperoid layers seem to stand nearly vertical.

3rd. The whole formation is rudely basaltified in small columns.

4th. The thickness visible, in an interrupted series of outcrops, seems to be about twenty feet.

5th. A little distance further west, and near the extremity of the point before reaching the "narrows," the exposed rock is slate again, at first horizontal, and then with a dip of eighteen to twenty degrees to the N. E. then S. again; becoming hid by trees the rock terminates, and the point too, the elevation of the hill being forty to fifty feet.

The close proximity of this flint and jasper locality to the next great underlying formation (syenites and slates) makes it one of great interest to the geologist, but so far as scrutinized, as yet the true relation of the two formations are not revealed by anything here seen, though there seems to be an unconformability between them. At the "narrows" is basaltic trap rising in characteristic bluffs and striking E. and W. with a face toward the north.

728. Rock of the island in Saganaga lake nearest the inlet from Gunflint lake, on the south side. This is a syenite with mica, containing much coarse quartz. The feldspar is orthoclase, of which the greater portion is white, but some of it is flesh-colored. It is a beautiful, light-colored syenite, suitable for ornamental purposes. This rock prevails about Saganaga lake, but also becomes darker by an increased amount of hornblende.

729. Syenite from "Cariboo narrows" N. E. ¼ Sec. 19, T. 66, 4 W.

Gull river and lake may be ascended by course to near the S. W. cor. of T. 66, 4, without portage, by passing two rapid places. Gull lake is thirty-nine feet above Saganaga. A portage is necessary at the third rapids. Gull lake is similar to Saganaga in having numerous islands based on a light-colored syenite.

W. Gull lake, which is united by a short rapid stream to Gull lake, is twelve feet higher, and is filled with the same sort of rocky islands.

730. Syenite from the rapids between Gull and W. Gull lakes.

Along the south side of these lakes, distant about two miles, runs a range of mountains which seems to be a continuation of that running west from the south shore of Gunflint lake, marking in general the northern limit of the slate and quartzyte group.

731. The rock 730 continues to form the islands and shores of W. Gull lake to near the point where the stream from Frog-rock lake enters it, near the southwest end, where the rock 731 takes its place, rising in little hills of very similar contour and size, some of each rising 50 to 100 feet. This rock is very tough, greenish, has in general an imperfectly schistose or fibrous structure, is seamed and jointed finely, some of the seams being filled with a fine-grained, siliceous, nearly white rock, or pinkish quartzyte, which is faulted frequently by other seams, making a zigzag network of joints and seams. Some of these

seams are of a pinkish color, and six to ten inches wide. But they are themselves broken and often entirely diffused and lost. The rock is not slaty, but separates under the hammer into rude rhombs. It is fine-grained. (V. Nos. 348, 355, 356, 358.) This rock in thin-section shows a matrix which is homogeneous, transparent, penetrated by the other minerals, and between crossed Nicols has a neutral color, darkening on rotation of the stage, with the quick limpid change characteristic of quartz, but not having its brilliancy. The other chief mineral is green fibrous hornblende, but it is so changed that it is rarely dichroic, and is often more like serpentine than hornblende in its optical characters. There are also a few grains of some triclinic feldspar. This composition seems to make this rock an amphibolyte. In land specimens it is not distinguishable from the amphibolyte of Littleton, N. H.[*]

The stratigraphic relations of 730 to 731 are not easy to make out. Sometimes they lie immediately in contact, the plane of separation being perpendicular, and sometimes they are in separate knolls, or hills, contiguous, the contact of which below the soil is not visible. In general the hills composed of the amphibolyte are higher and rougher than those of the syenite.

732. Light pinkish granulyte, or quartzyte, embraced in veins in No. 731.

733. Frog-rock lake, which is next west of W. Gull lake, is so named from the Chippewa word which signifies *spotted* or *greenish*, from the appearance of the rocks, and it is seventy-three feet above Saganaga. The mineral which gives green color to the rocks of this region appears sometimes in thin seams or in coatings on opened seams, as shown by the samples of this number.

734. This greenish rock in some places is very fine and tough, and also porphyritic.

735. At the very entrance to Frog-rock Lake is a hard, massive, speckled dioryte that forms a little fall where the water goes out of the lake In passing the portage, white quartz is seen in pockets in this rock (731 and 734) sometimes having perfect crystalline terminations.

736. From an island in Frog-rock Lake, about half a mile southwest from its outlet; a green amphibolyte (?).

737. A talcose or chloritic rock, having a coarse perpendicular schistose structure, from the rapids between Frog-rock and Town Line Lakes, northwest from Frog-rock Lake. This is conglomeritic, some of the pebbles being six inches across and like the gray amphi-

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[*] No 216, of the "typical rocks of New Hampshire," or No. 3,016 of the Museum Register.

bolyte (No. 731). There is in it also considerable pyrite. The pebbles are rounded, and are intimately connected with the matrix. There may be thirty feet of this here visible, including that below the water and above. There seems to be a S. dip of about 10 to 15 degrees. The aspect of the country changes at once on entering on this conglomerate. There are no bald, rocky hills to be seen around the Town Line Lake, but the trees grow all over the rock, and down to the water. The level of this lake is 83 feet above Saganaga, and King-fisher Lake (or Ogishki Muncie) is ten feet higher. The rapids connecting them are formed by the same rock (737).

738. A fine, firm conglomerate, or grit, containing considerable pyrite which changes to iron oxide near the surface The grains are mainly of quartz, as well as of flint and feldspar. Some of the flint is black, and two inches across. This rock recalls the Gunflint beds. It seems also that the rock 737 is a part of the same conglomerate as 738, but at a lower stratigraphic horizon. It hence seems as if the Gunflint beds, which are the lowest part of the quartzyte and slate series (the lower volcano of Logan) pass by a common metamorphism through the perpendicular slaty, or schistose structure into the slates of the Huronian—but whether at first conformable to them or not, cannot be said yet. This rock (738) does not continue far west of where it appears, which is near the N E. end of Ogishkie Muncie Lake, on the south shore. It stops at the first narrows, at the east end of the lake apparently jogging off south suddenly, since the rock 731 sets in in full force on the south side of the lake on the W. of these narrows, and continues to one-half mile west of the section line between sections 13 and 24.

739. At one-half mile W. of the section line; somewhat quartzyte, firm and resembling 738. This occurs suddenly in No. 731, and it weathers into large angular blocks, while No. 731 is apt to weather out in rough schistose fragments.

Directly across the lake, on the north shore the rock 738 can be found again appearing in a similar manner as on the south side, *i. e.*, in a bluff and hill near the lake, but 731 appears soon on the south side, and with sundry variations forms the south coast to the peninsula on the south shore crossed by the line between Secs. 23 and 26 which is made up of the quartzyte and slate, having a dip to the S. S. W. of about 80 degrees. The slate alternates with the quartzyte beds, the former being in layers generally of two to three inches, and the latter in beds of six inches to two or three feet. There is in the slate, which is slaty in the direction of the true bedding, also a tendency to slatiness E. and W. perpendicularly, so that the beds are apt to separate, when struck, both in the direction of the true bedding and along the weathered planes of the E. and W. slatiness, making thin lenticular wedges. This E. and W. slatiness is not visible in the quartzyte. The same alternation of slaty and non-slaty beds is to be seen on the S. shore of Vermilion Lake, and at Thompson.

740. Slate from the above.

741. Quartzyte from the above. This is much like No. 738.

742. Dyke-rock, from a dyke cutting the great conglomerate of Ogishkie Muncie Lake, N. W. ¼ N. E. ¼ Sec. 26, T. 65, 6 W. Plagioclase, magnetite, chrysolite, a little hornblende (?), a little quartz pierced by spicules of apatite and pyrite. This dyke is six and a half feet wide and runs E. 10° S. It crosses a little peninsula, and on both sides disappears below the water of the lake. It is a dark, heavy, firm rock, not differing from numerous others seen crossing the great quartzyte and slate formation.

743. Calcareous, rusty schist, apparently talcose, and overlying the next; this has a strong resemblance to the conglomerate schist No. 737. It is coarse, and seems to disintegrate more readily than any of the rocks of this region. It is in the lower places. It has no evident dip, or bedding, but a schistose structure running E. and W. perpendicular.

746. Associated with the last is a grayish marble, which may also contain siderite. They are in the N. E. ¼ N. E. ¼ Sec. 26, T. 65, 6 W. The marble rises in an inconspicuous low ridge, in a valley. It is coarsely jointed, and has an apparent dip toward the south of about 10 degrees, and is 22 feet thick.

744. From the great conglomerate, but showing one of the indeffinite conditions of the same. The conglomeritic character is hardly distinguishable on a fresh fracture of the rock which sometimes shows different shades of green. But all over the surface, when glaciated and weathered, are visible the forms of rounded boulders, included in the rock, the different colors and grain of the boulders being brought out plainly. This is essentially the same formation as the rock 743 and 737, and it constitutes by far the greatest part of the country rock about Ogishkie Muncie Lake. Wherein the rock 737 differs from 738 which also passes into 744 by the accession of slaty structure and then the obliteration or modification of it by the accession of boulders, it may be ascribed to varying proximity to and influence of the underlying "talcose" rocks in the process of deposition and metamorphism. The rock 744 forms the little island in the central narrows of Ogishkie

Muncie Lake*, near the peninsula crossed by the line between sectinos 23 and 26, and the mainland south and north. On the island, it is a real conglomerate, with a smoothly glaciated surface, and the sections of some of the rounded stones are a foot and even more in diameter. They are very abundant. Sometimes the rounded stones make three-quarters of the whole rock, but in other cases the slaty matrix is nearly free from them, over considerable areas. The general surface rises in short, zig-zag ridges which, though often entirely bare, have boulders and a thin soil of clay and mold in the valleys between them, so as to obscure their inter-relations. In these valleys are a multitude of fallen, half-burnt trees, among which are growing small birches and willows (V. after 752).

There is a sudden change in the direction of strike of the rock of the country, in the N. E. ¼ of Sec. 26, from nearly E. and W., to N. and S. At the shore on the peninsula in Sec. 23 it is the same as the slates generally seen in the Huronian, in this part of the State, but after passing the valley in which are the calcareous schist and the marble, it is N. and S. That the change is somewhat sudden is shown by the fact that the beds running N. and S. are seen to cease abruptly and to be replaced by the conglomerate in a number of places. The conglomerate in these cases is, so far as seen, rather finer than the average.

745. Slate and quartzyte, from the rock that strikes N. and S. (as above), showing the bedding of sedimentation, the tendency to E. and W. schistose structure, and the jointage to which the whole is subject.

746. (See before 744.)

747. Directly south of 745, (on the lake shore) *i. e.* in the S. W. ¼ S. E. ¼ Sec. 26, is the hard, black rock represented by this number. It is a kind of black quartzyte, or flint, the dip of which cannot be stated. It is finely jointed or broken, nearly at right angles transversely, occupies the area of a small ridge near the shore.

748. On the portage from Ogishke Muncie lake to Dyke lake, which is a little lake southwest from Ogishke Muncie in S. E. ¼ Sec. 28, is a siliceous slate, standing vertical. It is cut by a dyke running about N. and S. thirty to forty feet wide.

749. Rock from the above dyke; dark dolerыte.

750. Conglomeritic slate. This passes into the slate 748. It shows no bedding. From the north side of Dyke lake.

751. S. E. ¼ Sec. 30, T. 65, 6 W. north of the east end of Caca-

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*With one exception this is the only island which has its forest yet standing; most of the country being utterly destitute from fires.

quabie lake, is Mallmann's Peak. It extends rather as a lower range toward the N. E. half a mile, terminating at the end of the lake in the northern part of Sec. 29. This rock is a peculiar porphyry. The ground mass is amorphous, and the disseminated crystals are hornblende. It is unlike any thing before seen.

752. A dyke forty feet wide, represented by this number, cuts the last. This is a doleryte with considerable magnetite and pyrite.

Further examination of this great pudding-stone on the high peninsula that projects from the north shore of Ogishke Muncie lake, on Sec. 23, shows that it is crossed by E. and W. bands due to sedimentation. These bands stand nearly or quite vertical. They are similar to those seen in the quartzyte and slate, but are coarser and more indistinct. They are seen in the finer parts of the pudding-stone, when the rock passes into a fine conglomerate or coarse quartzyte.

On this peninsula nearly one-half of the pebbles in the rock, large and small, are from the Saganaga granite. Next in frequency is a variety of greenish pebbles, apparently from the same formation, or at least from the rock 731, and some like the dyke rock 742. Next comes quartzyte, which is sometimes gray, sometimes white. These graduate into white and gray pebbles, some of which are also black and very fine, like flint, having a short conchoidal fracture. Some of these last are banded like the jasper and flint of the gunflint beds. One banded piece of black-gray flint which was noted was a foot across. These various pebbles weather into a variety of colors making the face of the bluff perfectly spotted and mottled. The conglomerate is a part of the slates of the region, and is interbedded with them.

About three-fourths of a mile north of the central narrows of the lake, the conglomerate, which continues all the way, with a dip S. of 80 or 90 degrees, (sometimes varying a little to the S. E.) contains large, rounded pieces of the "Saganaga granite," which proves the greater age of that granite, and the unconformability of this slaty conglomerate, and the beds that are its equivalent elsewhere, upon that older formation. Some of these large pieces of syenite are over two feet in diameter. The conglomerate also here contains red jasper.

At about a mile north of the narrows the red jasper becomes very common, some pieces being six to eight inches across on the face of the rock.

At about a mile and a quarter north of the narrows the conglomerate becomes finer and finer, and the slaty bedding comes in, the whole being converted to 740 and 741, and at once the hills rise in a rude range, broken by off-sets, to the height of 150 or 200 feet higher than the general level. The highest hill is about in the center of the S. W. ¼ Sec. 14, and the top consists of the rocks 740 and 741, passing to 731, with vertical bedding. The strike of the northern limit of the conglomerate is S. 35° W. and at about one and one-fourth miles N. of the central narrows. Through the whole of this distance the dip is nearly uniform (80° to 90° from the horizontal); and by the construction of a right angled triangle a calculation will make a thickness of 6,574 .8 feet, for the conglomerate on the north side of Ogishke Muncie lake, and there may be as much more on the south side.

753. Is an average sample of the most of the hill on S. W. ¼ Sec. 14, T. 65, 4 W. (as above.) It represents a vast amount of rock in this country, since much, even of the conglomerate, is of similar rock. This here is banded with finer beds, approaching slate, which, when favorably weathered, falls to pieces as slates, though very siliceous.

From this hill the mountain-range on the south side of Ogishke Muncie lake can be seen to extend east as far as the eye can distinguish, and probably to Gunflint lake. The point of observation is E. 33° N. from Mallmann's Peak. Part of Knife lake is W. S. W. Toward the N. W. is a lake one-fourth mile away. East 33° north, is another small lake one-fourth mile distant, and at the foot of the hill S. is another little lake. Toward the north is a similar tract of country, burnt over, running to Otter Track and Knife lakes, made up (probably) of the rock No. 753, as no such conglomerate was seen along there last year.

754. Jasper conglomerate, one mile north of the central narrows of Ogishke Muncie lake.

The "Gunflint beds," south of Gunflint Lake, (V. after No. 747) have been associated with the slates and quartzytes of the overlying formation, rather than with the talcose slaty beds underlying (V. 426) but observations about Town Line and Ogishkie Muncie Lakes seem to indicate that they are here a part of a schistose, slaty formation, highly inclined, which belongs to the Huronian, passing into the great conglomerate of Ogishkie Muncie Lake.

So far as can be determined by the observations made, the following statement of the order of superposition seems to be warranted, in descending order (V. after 551).

1. The nearly horizontal quartzyte and slate formation composing the hills of the Grand Portage and the International boundary as far as Gunflint Lake.
2. The coarse grit or fine conglomerate, No. 738.

3. The Jaspery and calcareous beds that are known as the "Gunflint beds," Nos. 737 and 743.

4. Gray marble, No. 747.

5. The tilted, slaty conglomerate, and the great conglomerate, about Ogishkie Muncie Lake, Nos. 744, 750 and 754.

6. The amphibolyte and the chloritic slates, Nos. 731, 753, 348, 349, 350, 355, 356 and 358.

7. Mica schists, and alternations of mica schists and syenite, Nos. 335, 337, 339, 401, 406, 408, 414 and 417.

8. The syenites and granites of Saganaga and Gull Lakes.

There is yet one very important, undetermined question relating to this generalized section which ought to be borne in mind, viz : Is the great quartzyte and slate formation of the international boundary (No 1 of this section) the same as the highly tilted, slaty and quartzyte formation which passes into the great conglomerate? (No. 5.) There are some considerations which seem to imply that it is, though in all descriptions and sections they have been treated as different terranes. (a)Where the horizontal slates approach the syenites at the east end of Gunflint Lake there is nothing to be seen of any beds representing the tilted slates. The syenites and their associated schists come on at once. (b)Where the tilted slates and the conglomerates associated with them are traceable from the syenite upward to the gabbro as south of Ogishkie Muncie Lake, there is nothing to be seen of any beds like the horizontal black slates of No. 1. (c)The "Gunflint beds" appear to belong to the horizontal slates of the international boundary at Gunflint Lake, but their supposed equivalents at Ogishkie Muncie Lake belong to schistose and tilted slates and conglomerate. (d)Although the horizontal slates and quartzytes of the international boundary strike west and southwest across the State, forming one of the most important topographical features of the northern part of the State, and can be followed for many miles as such, yet they are lost entirely in the region of the upper St. Louis, and the tilted slates are the only ones seen where that river cuts the rock at Knife Falls and below. (e)The great gabbro belt, which surmounts the horizontal slates along the international boundary, and prevails to the east and south of their line of strike, is seen to pass to the west of Lake Superior, at Duluth, and to disappear from sight suddenly between Duluth and Fond du Lac as if its continuance depended on the maintenance of the horizontal formation with which it is associated. (f) Where the Gunflint beds become a jaspery hæmatite, as south and east of Vermilion Lake, the structure of the tilted slates passes into the iron ore as if of the same formation. (g)The formation which underlies the cupriferous at Fond du Lac is the tilted slates, and that which underlies it at Grand Portage is the horizontal slates.

A thorough examination of the hill-range between Gunflint and Ogishkie Muncie Lakes would probably reveal the facts as to any transition from the horizontal slates to the tilted slates.

In going south from Ogishkie Muncie Lake toward the mountain range, so as to strike the summit on Sec. 34, the dip and strike of the rock are seen to change several times. At the shore is a fine conglomerate, then quartzyte and slate in contorted bedding, then the same with a dip east, then the same with a dip northeast, then south, then coarsely arenaceous without any distinct dip, apparently once broken, then vertical with strike N. and S. South of the crossing of the creek, about half way from the lake to the summit, the rock is very confused (apparently brecciated and recemented), and the bedding cannot be made out. Then the dip is west, verging to southwest.

Although this is not all conglomerate, on close examination it seems to show in the field such variation as can be referred, very much of it, to an original conglomeritic condition. In approaching the summit this condition is less and less apparent, the stones gradually losing their identity in a common, more homogeneous mass.

South of the foregoing interrupted series of hills, occupied by the changes described, all pertaining to the conglomerate—quartzyte—slate formation, is the first ridge. The rock is rounded and smoothed by glaciation, though the direction of movement cannot be ascertained by any preserved striæ. There is a sudden change in the character of the rock of the hill in passing to the ridge.

755. The rock of this ridge is a greenish, tough rock, much like that of No. 731 in outward character, rather fine-grained, has numerous quartz veins and seams, and forms a large area and ridge on the mountain side. While outwardly it appears like No. 731 it has the mineral composition that more resembles a dark, fine dioryte (V. 684 and 678).

756. Passing further south, crossing a valley, another ridge is met with, rising higher, consisting of this rock—a coarsely crystalline dioryte, with a little quartz and magnetite, the hornblende being changed to viridite. It is cut by—

757, a gray, rather fine, trap-rock, in a dyke running N. W. and S. E., six feet wide.

Further south is another higher, bare ridge, broad and smooth, constituting the top of the mountain. The rock is—

758, a "trap" of a greenish color.

759. Occurs in patches in No. 758 and is like No. 756, but contains so much magnetite as to appreciably increase its weight. This is from the summit south of Sec. 35, about one fourth mile.

Of the rocks constituting the mountain east of Twin Peaks, Nos. 755 and 758, are the chief mountain-making rocks, and No. 758 is the most important, spreading a great distance still further south (judging by the form and color of the hills in view), and also probably a great distance east. Indeed, it is probably the rock that constitutes the divide, south of Gunflint and Tucker lakes, this range being visibly a continuation of that.

In passing from Ogishkie Muncie lake directly to Twin Peaks, the following observations were made by Mr. Mallmann. After a space of conglomerate, perhaps one half a mile, there is a gorge in which a creek runs S. 30° W., the rock over which it passes being—

760. A light siliceous marble, or calcarous quartzyte, undistinguishable from the marble, No. 746. On either side of the gorge is a wall of rock. On the west is conglomerate, and on the east is No.

761. which is a pyritiferous, dark aphanitic rock, one of the conditions of the slate of the slaty conglomerate.

762. Is from a trap dyke cutting the conglomerate, about one fourth mile from the lake.

South from the gorge is more conglomerate and quartzyte, then a ridge, or a succession of benches rapidly ascending. The first bench, 20 feet high, has regular bedding, and dip toward the south, but no basaltic structure. It consits of No.—

763. Which is apparently closely allied to No. 755.

764. In a higher ridge is this rock, which is the same as 763.

765. The top of the Twin Peak (E. Twin) is a fine-grained variety of the same rock. This peak, and the general average of the mountain range may be 500 feet higher than Ogishkie Muncie lake. The Twin Peaks are conspicuous because they stand isolated, further north than the rest of the high land, not because they are higher.

Fox lake, which is 141 feet higher than Saganaga, affords a fine exhibition along its south shore, of the broken condition of this quartzyte-slate-conglomerate formation. The bluff rises nearly perpendicular, but is somewhat rounded off by glaciation, and the edges of the bedding cross the face of it in a very tortuous and angular irregularity. Some of the beds which are nearly horizontal are terminated at one place by a perpendicular line, on the other side of which the beds are nearly vertical. In other places the bluff shows both synclinal and anticlinal bends.

Ash lake (or Agemok lake) is 200 feet above lake Saganaga. On the portage from Fox lake to Ash lake the formation strikes S. E. and N. W., with a dip S. W. of 60° to 80°, the most of the way. It then changes suddenly to a strike S. W. and N. E., and then soon becomes confused in a general breccia. Near Fox lake, where the beds strike S. E. and N. W., there is a ferruginous belt. Through about four feet the hard slates are rusty with hæmatite. The pieces are also feebly magnetic, but there is not enough iron to be of any value.

766. Iron ore near Fox Lake.

Gobbemichigomog lake is 210 feet above Saganaga. At its west end, just west of the town line is a northward facing hill of bedded trap, and a low range runs along the south side of the lake, but the main hill-range strikes along north of this lake, jogging a little to the north.

767. From the south side of Gobbemichigomog lake. A fine-grained heavy rock of a gray color, resembling the rock No. 677, evidently having much chrysolite.

There are several short perpendicular bluffs of bedded trap, some of it approaching the last in characters, along the south shore of Gobbemichigomog lake; and one of them is quite ferruginous. They rise from 20 to 40 feet. From one near the lake is obtained—

768. Somewhat irony trap, with chrysolite and mica.

Crooked lake is 217 feet above Saganaga, and Little Saganaga is 225 feet. About Crooked lake the country is wholly in the trap of the Mesabi. It rises in numerous knobs that make rounded, bare islands. The same rock continues to and into Little Saganaga lake where it also causes many islands. In some places it rots and crumbles easily as at Beaver Bay.

769. Trap, from the N. W. end of Little Saganaga.

770. On the south side of Little Saganaga the rock weathers white. It rises in higher bluffs, resembling the Rice Point gabbro, and even approaching the whiteness and nearly the purity of the so called "feldspar rock." It is mainly of feldspar but also contains magnetite and a little pyroxene. The hills and ridges show in general a course bedding which dips south. Ridges 10 to 50 feet high. The sample collected is weathered. Boulders of iron ore like that of Mayhew lake, are scattered about.

East-and-West lake is 231 feet above Saganaga.

771. Pinkish-red vein of syenite in rock No. 770, dipping E. 75°. It is 20 inches wide, on the south shore near the east end of East-and-West lake. This red syenite here is comparable to the red syenite asso-

ciated with the gabbro at Rice's Point. In both places it penetrates irregularly through the gabbro.

The lake in Frog Rock river is 241 feet above Saganaga. On the portage north from the lake in Frog Rock river are to be seen several veins of red syenite in the feldspar rock of the country, like 771 dipping E. The dip is generally south, about 50°, but is also S. E., E., S. W. and even N. W.

772. From a vein, one foot wide, of this rock in the neighborhood of the east-dipping red veins. This is coarsely crystalline, and consists of the usual minerals in the gabbro of Rice Point, but also here seems to have quartz and mica, perhaps derived from the red rock with which it is in close association. This whole formation resembles "Rice Point granite" in outward characters, and in mineral composition. It sometimes decays in round masses, as if at first a conglomerate, in the same manner as near the Duluth depot. (V. No. 4 A.) The last lake in Frog Rock river is 258 feet above Saganaga. Passing from this lake by a long portage toward the southwest, the Mesabi lake is reached, 338 feet above Saganaga lake.

773. Rock of the country, about the last lake in Frog-Rock river. It is a gabbro. This formation not only seems to be the "Rice Point granite," and the iron-bearing rock of Mawhew lake, but also to have furnished the feldspar masses of Castle Danger and Beaver Bay. The portage from the last lake in Frog-Rock river to Mesabi lake rises 150 feet, and passes nearly all the way over this rock. Merabi lake is 70 feet lower than the divide, and its outlet is toward the north, uniting with Frog-Rock river.

The same rock continues nearly across the portage to Duck lake, where another formation sets in, viz:

774. This comes in apparently *through* No. 773, at first, but afterward it lies on 773, and in rude lenticular and broken bedding dips to the south. It forms a range of hills about 100 to 150 feet high next west and south of Mesabi and Duck lakes. It has been molten, as evidently as 773, and in that sense it is an igneous rock, but it differs from it in its mineral composition. It is a reddish syenite, but seems to contain mica, as well as some plagioclase. In passing along Duck lake considerable confusion prevails in the relative positions of Nos. 773 and 774. Along the south side of the point that separates the lake into N. E. and S. W. parts, No. 774 plainly lies on parts of No. 773, but on the east side of the lake, there is considerable mixing, the two changing places suddenly, and either one being in patches in the other

—particularly 774, embracing masses of No. 773, and suddenly cutting No 773 like dyke-rock.

775. At the S.·E. end of Duck lake 773 lies on 775, which is the well-known and so-called "red granite." This lies in even and regular beds of four to eight inches, (or in beds of three to four feet), dipping south, amounting in all to about twenty feet, the rock 773 being unconformable on it, but intimately cemented to it, as at Rice Point. Over both of these, further toward the S. E. No. 774, comes in again. (V. 776.)

Duck lake is 345 feet above Saganaga.

L. lake is 413 feet above Saganaga.

The portage is along the stream between these two lakes and is over the rock—

776, which is seamed and blotched with the red rock 775 and appears to be affected by it throughout. This rock prevails through this portage with occasionally a characteristic patch of No. 773—as seen at the south end of the portage. At the point where the portage leaves L lake is a bluff at the left made up of the following (777-780.)

777. A characteristic gabbro, seamed by red syenite, and weathering nearly white, porphyritcally, so as to appear much like No. 773. This passes downward into—

778, which was obtained about thirty-five feet below the top of No· 777 and near the next. This is apparently a form of the gabbro when in closer contiguity with the sedimentaries and has been penetrated by minerals from them. It is finer-grained than No. 777 and darker, but also seems to have orthoclase and mica. These together, make a thickness of about forty-five feet, from the top of the bluff downward. They are one in structure, dip and general characters. They dip south in heavy layers at an angle of about thirty degrees.

779. Red syenite, unconformable under 778, showing about fifteen feet. What appears like bedding in No. 779 may be coarse jointage, as there are two sets of planes, one set being perpendicular to the bedding of the gabbro overlying, and the other crossing it so as to have a dip south of about seventy degrees.

780 is a form of the rock in the same bluff about twenty feet below the top—evidently a part of the igneous rock, but affected by proximity to the underlying rock so as to appear like a dioryte.

There is a striking contrast in the appearance, form and color of the rocks 777 and 779.

Wind lake is 473 feet above Saganaga lake. On the portage to Wind lake the rock No. 777 is the prevailing rock at first, but is varied by patches of red rock, and a fine-grained rock like No. 778. Then—

781 prevails, cut by seams of red rock like the last, and having sudden variations to Nos. 777 and 778 and even to No. 774. This is a light-colored, fine, syenitic granite. The red rock continues to increase in area till at Wind lake, nearly one-half of the visible area is of red syenite, the rest being some of the rocks 777 or 781. The most of the surface is bare rock and can be examined easily. The red syenite is in the lower parts and the other rocks are in the higher. It always appears to come out *under* the others when it appears in bulk and indicates its proper relation to them. The red seams which pass upward into the dark rocks are exactly simulated by the same relations of the gabbro and the red syenite at Duluth, and this place must be at about the same geological horizon. There is much reason to regard the rocks 773, 774, 776, 777, 778, 780, as all phases of the same great formation, an igneous rock which flowed over 775 and 779, and in contact with them was modified into the various textures and degrees of fineness that they illustrate; and that the red rock, which must be regarded as the red formation of the Brulé and the Great Palisades, in the process was fused and injected into them. This red formation, which makes red syenites and gneisses, belongs in the lower portion of the cupriferous, as hitherto classified, and seems to be the same that in Michigan has been grouped by T. B. Brooks in the Huronian.*

Along the north side of Wind lake, these formations, the red and the gray, are somewhat interbedded, and so brecciated and mixed that the bluffs are spotted promiscuously with the two colors. Sometimes, also, they seem to have been fused and blended into a rock that is neither red nor gray.

782. A micaceous quartzyte, of a light red color, from the S. E. side of Wind lake. This is less granitoid than usual, but is still a part of the red rock formation.

783. A micaceous brown quartzyte, of the same series of rocks, from the S. E. side of Wind lake. This is one of the metamorphosed sandstones of the cupriferous.

At the place where the portage trail leaves Wind lake is a bluff which in form is a duplicate of the red quartzyte bluffs at New Ulm, and in Rock and Pipestone counties.

784. Is from this bluff, and constitutes the most of it. It is a hard, red, fine, sub-granitzed quartzyte, somewhat sprinkled with darker specks, that may be chloritic or micaceous, or graphite, and having

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*Am. Jour. Sci. (3), XI. p. 206.

rarely a distinct crystalline grain of orthoclase. It is in distinct sedimentary layers that dip S. at an angle of 20° to 25°.

785. In irregular patches and areas, on the face of the bare bluff, rounded off by glaciation, may be seen this rock, which is a true igneous rock, nearly black, fine-grained, a trap-rock, a form of the gabbro such as is seen along the Lake Superior shore where the molten material was rapidly cooled in contact with the sedimentaries. This is a phase of the igneons rock of the country. This bluff throws light on the geology of the southwestern part of the State. If this gabbro belongs to the cupriferous, and these red gneisses also, then may not, not only the red quartzytes (Sioux quartzyte of Dr. White, and the Baraboo quartzyte of Wisconsin), but also the contiguous red gneisses and granites of the Upper Minnesota Valley? In other words may not the red gneisses and granites of the Upper Minnesota Valley be in the extension of the great modified cupriferous, where instead of an actual molten outflow, or series of outflows, the disturbing agencies operated to produce a widespread and complete metamorphism in the contemporary strata? Those granites and syenites differ widely from the granites of Saganaga—the only ones known to lie below the great conglomerate of Ogishke Muncie. Though the rock of this bluff is not a pure red quartzyte, in other places this red rock is a pure quartzyte which can hardly be distinguished from the quartzyte of New Ulm. At the same time there are portions of the southern red quartzyte that are as much granitized as the rock of this bluff. This is particularly true of the outcrops at Baraboo, Wis.

Spotted Rock lake is 520 feet above Saganaga. This lake is so named because of the mixture of red and gray rock as described at the south end of Wind lake. Here it is all about the shores, the red gradually increasing in area, and rising into hills.

At Little Saganaga lake were a few green trees of Jack pine (Pinus Banksiana) about three or four inches in diameter, but south of that lake the country has been twice burnt over, as at Ogishke Muncie lake, so that it is almost bare of vegetation. The first burning destroyed the large trees, and the second, in burning the fallen forest, killed the new growth, which was then one to two inches in diameter. About Little Saganaga this young growth escaped the second fire; but in nearly all parts of this traverse the country north from Young Sawbill lake affords unrivalled opportunity for unraveling the geology of this much-studied but little-known horizon of the earth's crust.

Leaving Spotted Rock lake the canoe route passes over a long rough portage trail, crossing the hill range known as the ***Mesabi Range.***

This range seems to be the westward extension of that in which is Brulé Mt., while that "Mesabi" which passes near Gobbemichigomog lake has been distinguished sometimes as the Giant's Range. Sawteeth Range is near the Lake Superior shore. The Mesabi range rises where the trail passes it, 676 feet above Lake Saganaga, or 1,592 feet above Lake Superior. The dark rock which is mixed with the red granite formation continues to the top of the Mesabi, having its usual changes of texture, and a few spots of red rock. But before reaching the summit the texture becomes what is shown by—

786 without much variation. This is from near the top of the range. This is rather fine, heavy and chrysolitic. After passing the summit the formation is occasionally coarser, and even takes the characters of No. 773 in small patches and veins.

787. Its prevailing features on the south slope are shown by this number, which is like other samples from the same formation elsewhere, a rather fine chrysolitic gabbro, which continues to South-side lake. From the top of the Mesabi range can be seen both the Giants range of hills and the Sawteeth mountains.

South-side lake is a tributary of Temperance river.

From South-side lake the course pursues a slow-running river to Sawbill lake, with ridges of rock No. 787 on either side rising about fifty feet, or less, occasionally with a little show of the red rock, but generally free from it. From Sawbill lake the canoe enters a swamp through which the same river flows, to a rapids, where, after a short portage, a lake is reached in the same stream, the same rock continuing. This is known as Young Sawbill lake, and by our aneroid is found to be 454 feet above Saganaga lake. At the rapids the same rock appears, but about Young Sawbill lake the country is drift-covered, and about the S. W. end of this lake the native forest is green, having escaped the fires. This, however, does not continue far, for at the south side of Rat lake the forest is fire-killed. No rock is seen on the portage from Young Sawbill to Rat lake, but where the trail leaves Rat lake for Burntwood lake the same rock as the last appears.

Rat lake is 459 feet above Saganaga, and Burntwood lake is 439. These are both tributary to Temperance river.

On the portage from Rat lake the formation is mixed with the red syenite. It shows the characters of the Rice Point gabbro, and irony patches like dykes, having much magnetite.

On the east side of Burntwood lake the same rock can be seen in place, but the prevalence of drift and the greater amount of vegetation, makes the examination of the geology of the country more difficult, and the idea one can obtain is more general than in the country north of the Mesabi range.

The portage to Temperance river passes over a range of low hills made up of rock like much of that already mentioned, belonging to the same formation, but somewhat darker colored, with magnetite and hornblende, approaching dioryte.

788. Dioryte from the E. side of Burntwood lake, the rock of the country.

789. From the portage trail to Temperance river lake, but rather darker than the average—a dioryte with much hornblende and considerable magnetite.

Temperance river lake is 417 feet above Lake Saganaga. This lake, which is nothing more than an expansion of the river is terminated by rapids which have a descent of eight feet. On the portage round these rapids almost the only rock seen as boulders are of the red syenite series. A lower rapid in Temperance river has a descent of thirty feet. Temperance river is rather a succession of lakes, or lake-like expansions. The portage round the last rapids crosses red syenite all the way, seen occasionally in place. The forest is killed by fire over the east half of the portage. At the foot of these rapids is another lake-like enlargement of the river, after which the route ascends by portage, a tributary of Temperance river, and reaches a lake in this tributary, which is found to be 419 feet above Saganaga lake. This last portage passes at first along the foot of and then ascends and continues on a ridge of morainic drift, consisting so largely of red granite masses (from one to six feet) that one could travel the whole three-fourths mile without stepping off them. There is also in the mass occasionally a boulder of dioryte like No. 788 or 789. When burnt the whole country appears red, from the prevalence of this red drift. The next portage leads to a lake in Poplar river, and the lake is given an elevation over Saganaga lake of 449 feet by connected aneroid readings. Through this portage the red morainic drift continues, and along the lake also. Near the lake appears—

790, in one of the ridges over which the trail passes. It seems to make up a large part of the ridge. It is a very fine-grained, gray, metamorphic (?) rock, or fine basalt.

Along the west shore of Poplar river lake are two exposures of the rock No. 790, and from the fact that in one place a lot of red granite is embraced in it, it is judged to be an igneous rock.

791. From one of these exposures, which is almost exactly the same as 790.

Although there is abundance of drift along Poplar river, the red boulders are almost entirely wanting.

Square lake is 444 feet above Saganaga.

Small lake is 437 feet above Saganaga.

There is still a considerable sprinkling of red syenite in the drift along these lakes. New varieties of rock also appear, such as the trap rocks of lake Superior, and amygdaloid. The forest, fire-killed generally since leaving Temperance river, is still standing. Camp lake is 425 feet above Saganaga.

Smoke lake is 411 feet above Saganaga.

Sunrise lake is 399 feet above Saganaga.

Rice lake is 394 feet above Saganaga.

Big Lake is 304 feet above Saganaga.

There are rapids between all these lakes. The long portage from Rice lake S. E. is wholly over drift, no rock in place being visible. The same is true of the three portages last before. The country is rolling and shows many boulders. The stream leaving Big lake is three times the size of that leaving Rice lake.

Sucker lake is 274 feet above Saganaga.

Poplar river, where the portage from Sucker lake strikes it, is 16 feet above Saganaga. The portage between Big lake and Sucker lake is wholly over drift, showing no rock. That also to Poplar river is over a smooth surface of drift, without once showing rock in place. After a descent by river of about five feet, rapids occur which have a further descent of 40 feet, bringing the river here to the level of 29 feet below lake Saganaga. After a further descent of three feet by river the last portage begins, leading to lake Superior, which is found by the series of observations to be 737 feet below Saganaga, or 179 feet less than the series of aneroids of 1878, from Grand Portage.

The Sawteeth Mountains through which the Poplar river passes in a narrow deep gorge, rise above the trail which runs near their base 563 feet, and 1111 feet above lake Superior.

These mountains seem to be made up, here, of the trap-rock of the shore series, but become coarsely crystalline, or porphyritic, gradually, toward the top, as shown by samples obtained at different elevations, viz:

792. From the foot of a hill facing north precipitously. N. E. ¼, Sec. 20, T. 60, 3 W. on Poplar river. This is a high, trap hill, like others in the vicinity.

793. From the foot of the last hill (or nearest Lake Superior), west

side of Poplar river, 600 feet above the lake, similar to the last. A chrysolitic trap.

794. From the same hill one fourth way up. The same rock, with an occasional crystal of twinned feldspar porphyritically displayed.

795. From the same one half way up. The same rock with coarser feldspar crystals.

796 From the top of the hill, 1111 feet above lake Superior. This is the same rock, with more abundant coarse feldspar crystals, the matrix, which constitutes about one half of the mass, being undistinguishable from the rocks 793 and 794.

There may be beds of amygdaloid in this hill, but none were seen. On the very top of the hill is red clay drift, and boulders, and the last portage trail is over a nice plain of red stony clay, gradually descending to Lake Superior—the lower half of it being suitable for farming. The actual connection of this hill with the rock of the shore is not visible along the trail on account of this drift. The only opportunity for tracing it out there would be in the difficult, if not impracticable, ascent of the river gorge itself.

Rocks from various parts of the State.

797. The trap of Taylors Falls, (V. 820.)

798. Porphyritic trap, of Taylors Falls.

The number 797 contains nothing that prevents it being classed as an igneous rock, and it may be of the cupriferous, but the latter (798) has hornblende and orthoclase, as well as epidote, and has the aspect of a metamorphic rock.

799. Light-colored syenitic granite. Saganaga lake: The first island on entering the lake from the east; same as No. 316.

800. Syenitic granite, from the falls of Gunflint river, at the first portage going north from Gunflint lake; the same as No. 315.

801. Gray, micaceous syenite. From S. E. ¼, Sec. 17, T. 35, R. 30, about two and one half miles S. E. of St. Cloud, on the east side of the Mississippi river. A large, rounded knoll of this syenite was opened in 1881 by Saulpaugh & Company for use in the piers of the R. R. bridge over the Missouri at Bismark. It is a rather coarse rock, consisting mainly of quartz, orthoclase, hornblende and black mica. The orthoclase is only in part flesh colored, the rest is nearly white. This knoll covers 25 or 30 acres and rises about 20 feet above the general surface, the longest diameter being E. and W. (a little N. of W.) but oblong. A dyke four feet wide cuts it N. E. and S. W. consisting of heavy trap rock, very fine grained, viz:

802. Trap dyke cutting No. 801 in direction S. W. and N. E.; 4 feet wide. This rock, being much jointed, would facilitate the quarrying of No. 802, had the quarry been started along side of it.

803. Red quartzose syenite from an old quarry of Breen & Young, E. St. Cloud. In general the "red granite" at E. St. Cloud is but a small part of the whole of the rock.

Between the quarry of Breen & Young and that lately opened by Saulpaugh & Co, is a ridge of high land running E. and W. (nearly), which seems to consist of drift materials.

804. Gneiss, from Granite City. (Garrison.)

805. Light colored syenite, Watab, like No. 801, but rather finer in grain.

806. Light, red syenite, Watab.

These last two numbers represent the stone going into the piers of the Bismark R. R. bridge, quarried here also by Saulpaugh & Company. The gray is changed to the red in an interval of about six inches. The north portion of the quarry is red, and the rest is gray. These two numbers seem to duplicate numbers 801 and 803. This range of syenite runs N. and S. at least two miles, and some of the knolls rise 10 to 20 feet. East of this quarry are said to be similar knolls, some of them rising 25 or 30 feet. (V. No. 835.)

At Duluth the rock No. 43, which outcrops near the railroad in the street in front of the Engine House, where it has been quarried lately for use in the basement of the new School-House, and extends N. E. to the falls of Kinichigaquag creek, makes an important member of the rock series visible on the hill-slope at that point. Much of it is bare, north-east of the Engine House, within the limits of the city, showing, on weathering, a finely and indistinctly porphyritic structure, but in the main it is a massively bedded, homogeneous, dark rock, with numerous joints, the surface being frequently glaciated.

807. Passing toward the N. W. from the line of strike of No. 43, and thus onto rocks underlying No. 43, at the distance of about one-fourth mile, (but also somewhat to the westward) a rough, blotched rock is found spreading over a considerable area, running in the same general direction as No. 43. This, in general color, is like the last, but it is much finer in grain, and owing to its rough and blotched exterior under the weather, it must have been a conglomerate at first. Were it not for this blotched exterior, which shows a variation in composition, it would be placed at first in the general class of fine basalt, or diabase—like some of the narrow dykes, or like the rock adjacent to a dyke where the heat has baked it and allowed it to cool rapidly, leav-

ing it nearly black and very fine-grained. This conglomerate, while closely connected with the gabbro range, is unlike anything seen in the Cupriferous, and recalls the great conglomerates of Ogishke Muncie lake, although no tendency to slatiness can be seen anywhere. It has occasional light quartzose nodules, somewhat micaceous, but the most of the pebbles are of the color of the rock, except on weathering. In other places, by reason of the weathering, and the fires that have prevailed, a red banding is seen rudely conformable with the supposed bedding, which, on being broken reveals a texture and fracture as well as color and hardness, of the quartzytes of Pigeon Point. This No. (807) illustrates this gray quartzyte, but not the general character of the conglomerate.

808. Underlying this supposed conglomerate is the red syenite, or at least a red quartzless rock, (which is sometimes brown rather than red) which is associated intimately with the gabbro at Duluth. This red rock is to be seen in irregular patches in the gabbro on the hillside; and by carefully following it downward, it is seen to outcrop along the bottom of the creek in such proximity to the conglomerate, with a dip S. E. as to throw it under the conglomerate, unless there be in some way unusual irregularity in the trend and extent of these beds. The red rock is visible under the bridge, and above it in the creek, on the diagonal road going N. toward the Weller Farm, yet within the limits of Duluth. (V. Nos. 42 and 43.)

By following the strike of the red rock westwardly the following facts can be ascertained by anyone:

1. It falls away, except on the higher slopes, or breaks away so as to disappear, for the distance of about half a mile, though a lower strike appears near Superior street. (No. 42.)

2. This interval is followed by a rock showing orthoclase in the gabbro, as well as quartz, as in the rock at the Depot, (No. 5); and in the lower slopes N. E. of the the Rice Point quarry, this character is abundant. This seems to be explicable on the hypothesis that the gabbro flowed over, fused and mingled intimately with the red rock. But it may be of a lower rock horizon, referable to the horizon of the diorytes and their associates in the rocks of the northeast angle of the State. (V. Nos. 671 and 709.)

3. This "red rock" which is in much of its area, quartzless, becomes the red syenite that has been described as mingled with the gabbro, then showing quartz.* This is probably due to the complete

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*See *Proceedings of the American Association for the Advancement of Science*, 1881. Cincinnati Meeting.

fusion of the original sedimentary beds, allowing the otherwise invisible quartz, disseminated cryptomerously, to become aggregated in crystalline grains. At points more distant from the gabbro the only crystals to be seen consist of orthoclase, or of orthoclase and changed hornblende. The number 808 represents the complete crystallization of the elements, and is from Newson's old quarry, at Duluth, while Nos. 7 and 42 are from the same without the crystallization of the quartz.

Owing to the great general resemblance of the conglomerate (above) in its matrix at least, to the rock No. 43, which is seen in front of the Engine House at Duluth, and which overlies the conglomerate there is reason to suppose that they belong together, and that hence they are both of the metamorphic series. If the red rock be of the cupriferous, these must be, since the former runs below the latter. The question then arises, why is this dark-blue or black, and the red rock red. This cannot be due to greater heating and baking, which sometimes has been the cause of black rocks, locally, as described on the Lake Superior shore, in No. 52, and at other points, since under such circumstances the red rock remains red. Hence this seems to be due to difference of original constitution, making it resemble the rocks of the Animikie Group.

809. At Boyle's quarry, on the railroad above Fond du Lac, is a layer of red shale, lying in the heavy sandrock, which is much like the pipestone from Pipestone county. Its greatest thickness is sixteen inches, and it extends at least thirty feet, when it disappears under the drift clay.

At the quarry on Mission Creek, a short distance above Fond du Lac, in the *light-colored parts* of the sandrock are streaks and shades of red or brown, both in those parts having oblique sedimentation, and in those having horizontal. In some cases these dark streaks embrace lenticular pieces of shale, in which case the central parts of the pieces embraced are red or brown, and the outer crust is green. In some pieces the whole is green, or has a very faint central shade of red. On the contrary *in the brown parts* such red or brown lumps of shale are wholly brown, and have no crust of green. This seems to show that the original color of the shale lumps was red or brown, and that by some chemical reaction those in the lighter beds of the formation have become wholly or partly green. Thus, green specks and sometimes large green spots, at least green lumps of shale, are disseminated through the lighter beds, and red lumps through the dark brown beds.

810. Coarsely crystalline "feldspar rock" from two and a half or

three miles below Beaver Bay, showing coarse lamination, and evident striation. (V. No. 814.)

811. "Red granite," massive, from the large red granite island three or four miles below Beaver Bay which is arched on the lakeward side.

812. The "palisade rock," two miles west of the Palisades, S. E. ¼ Sec. 32, T. 56, 7 W., resembles the gray slaty rock at the mouth of Beaver Creek. In some places the Palisade rock here has the appearance of being crumpled, and also of having been originally in some places a conglomerate. Another bluff of light-colored Palisade rock occurs about one and one-half miles west of the Great Palisades. The trap rock which occupies the coast between here and the Great Palisades, runs under this Palisade rock toward the west. It shows a broken and zigzag line of junction with the palisade rock, parts of each penetrating the other, as if each were nearly molten. A little further west it also embraces masses (say ten feet) of the palisade rock, hardened and blackened by quick cooling, showing its sedimentary (or other) closely jointed structure in marked contrast with the massive or heavily bedded, non-conforming layers of the trap. (V. No. 52.)

The west end of the Palisades rises over the greenish and reddish (and then amygdaloidal or red porphyritic) trap, very plainly.

813. (V. 140) The lowest visible part of the rock at the Great Palisades, is confused and crumpled, in the same manner as where this rock is in contact with trap a short distance further west, as noted above. Yet it is very difficult to see the underlying trap, on account of the continuous heavy talus. This number represents *the red* banded felsite from the bottom of the Great Palisades.

There is apparently a continuous belt of this rock underlying the Palisades, outcropping in a narrow belt near the water. It is mingled in various ways with a crumpling of banded rock like that of the bulk of the Palisades (139), and with crumpled bands of light color, some of which stand verticle, or are curved obliquely, some of the latter showing a porous or even a spongy condition due to the solution and removal of some of the minerals. There is also a hard, dark, brittle, fine felsite, though porphyritic like the rest, but occurring in nodules and concentrically banded masses which endure more effectually the weather. They seem a more hard-heated and burnt condition of the Palisade rock. Indeed great confusion exists at the bottom of the Palisades, due perhaps to the forcible injection (as laccolites) of igneous rock below, breaking, crumpling, baking, fusing and metamorphosing rapidly the adjacent beds.*

814. There is one place two and one half or three miles east of Beaver Bay, where the "Feldspar rock" is bedded, and dips easterly, in all respects like the usual trap of the shore. It here shows also a confused mixture with the trap, in which in other places it seems to be (and is) embraced as isolated masses, as at Splitrock Point. This bedded condition is very evident in coming from the N. E. as the conspicuous surface slopes in that direction. Narrow dykes of fine-grained, gray doleryte cut the feldspar rock. One dyke is six inches wide, and one is about nine. They are about parallel, 25 feet apart and run E. and W. by compass. The feldspar here is very coarsely crystalline and is represented by No. 810. The alternate beds consists of bands of coarse crystals, succeeded by layers of fine crystals in which are also numerous grains of a more rapidly disintegrating mineral which by becoming disseminated stains the whole of a green color. This disintegrating mineral seems to take the place of the augite seen in the gabbro, therefore, the bedding is an alternation of gray, coarse feldspar, with green, decaying gabbro. No. 814 represents the feldspar stained *with the green-weathering mineral.* The bands of color are from three to six inches, fading into the uncolored, clear, feldspar, above and below. About 20 feet of this bedded feldspar can be seen here. (V. 694.)

815. From the same place as 814, represents the gabbro of more massive character with which the feldspar (810 and 814) is confusedly mixed, but between which there is not seen here any gradual transitions.

From the Palisades, (and Baptism river) to Splitrock, is one great igneous bed, which by appearing and disappearing at the waterline, seems to have been the principal agent in bringing out the geology and causing topography. It lies under the rock of the Palisades, and under the red islands &c., as at Beaver Bay, and over the feldspar knobs, from both of which it has derived fragments. The metamorphosed red shales above, making the red series of crystalline and semi-crystalline rocks of the shore, were apparently brought into that condition by the agency of this igneous rock, but the relation of this igneous rock to the "feldspar rock" is not so easily ascertained. It is certain that the gabbro of Rice's Point is only the usual condition of the feldspar rock,

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*The immediate proximity of igneous rock, along the coast usually, does not show the most perfectly changed and crystalline condition of the sedimentaries, nor *vice versa*; but when large bodies of either are involved the crystals are best formed The immediate contact is a place of crypto-crystalline rock, both rocks tending to suddenly become alike, and generally almost or quite black.

and hence that the gabbro range of which Rice Point is the western termination, lies below many feet of red, metamorphic sedimentary beds that apparently belong to the Cupriferous.

816. (V. 532 and 551.) Pieces of rock like the "Rice Point granite," embraced with evident feldspar boulders also, in the trap at Beaver Bay, sometimes in large blocks. This seems to be the same rock as the "feldspar rock" or a variation from it. Indeed there are here also masses of coarsely crystalline, green, trap-rock embraced as isolated blocks, in the finer green trap. *The gabbro, and the "feldspar rock" all pre-existed, and bore the same relation to an outflow of later igneous rock.* This point shows a wonderfully confused and brecciated condition prior to the final cementation.

The red rock appears, at Beaver Bay, as pebbles and boulders in the dark trap, and as strings and veins. It is in contact with masses of feldspar, crowded between it and trap. The spots and masses of red rock are distributed, in some cases with pieces of the feldspar rock, throughout the trap, showing the accession of both ingredients when the trap was molten, and even contemporaneously. The "feldspar rock" is derived from previously hardened outflows, and the red rock from the sedimentaries at the *locus* of the outflow. It is true that a long interval of time may have elapsed between the former and the later outflows; or indeed that the "feldspar rock" is of an entirely different formation earlier. Any older formation might furnish loose masses to an outflow of trap.

The interesting facts about Beaver Bay may be summarized thus:

1st. The feldspar masses are blocks detached from their parent rock.

2nd. The trap in which they are embraced is in some places much affected by the infusion of minerals from the sedimentaries, and then shows a reddish color, but it is generally of a greenish or greenish black color.

3rd. Besides this effect on the trap, as seen near the mouth of the creek on the north side, there are included masses of red syenite, and of the ashen-brown, or purple, rock seen near the mouth of the creek. (Nos. 127 and 528.)

4th. These red masses are sometimes in contact with and firmly cemented as by fusion to the feldspar surfaces, and also show a basaltified jointage.

5th. The red syenite here can hardly be called syenite in all cases, but is instead a nearly black (at least a dark purplish) fine-grained rock which in outward characters resembles the Two Harbor rock, but at the same time shows translucent, angular grains like the Palisade rock. This fine-grained condition is seen when it is near the rotting green trap.

6th. The red syenite here was apparently at first a red conglomerate, showing the irregularities of color, hardness and minerals that such a metamorphism produces.

7th. There is within a few inches a passage from the red crystalline characters of the bluff on the south side of the creek to those of the above fine-grained black rock, the rock being one continuous mass.

8th. The red rock is not only a metamorphosed conglomerate, but it was brecciated and then mingled with the trap so that angular pieces appear in the trap when worn off by glaciation.

9th. The red rock was fluidized. It runs about in belts and veins, not only between the trap and the "feldspar rock", and through the trap, but also through the "feldspar rock."

10th. The feldspar rock here passes into gabbro, or at least into a rock like the Rice Point rock, and then it is more generally mixed with the red rock.

11th. On close examination it appears that even as "feldspar rock" it must have been as completely molten as the red rock itself.

12th. This red rock also appears as the palisade rock, rising in a knob near the creek, on the north side, with the lithologic characters and jointage, and translucent grains of that rock.

13th. Under this knob lies a rotting green trap, visible on the north side. A little further east, but within the bay, this green trap, although basaltified, is beautifully mottled and striped with the red rock.

14th. Still further east, on the north shore of the bay, the green trap holds both red masses of the sedimentaries and white masses of the feldspar rock, the latter being, however, more nearly like the Rice Point rock, at least in some large masses—yet much of it is unmixed and clean feldspar.

The above observations, carefully made at Beaver Bay, seem to decide certain points that before were largely hypothetical, or were based on generalizations from a grand review of the geology of the "north shore," and not on special and minute study of the notes made or of the specimens collected.

(1.) The Great Palisades are of a rock, the equivalent, geologically, of the slaty quartzyte (Nos. 127 and 528) at Beaver Bay and below that point; and to the red syenite of the islands below Beaver Bay, and of the west bluff of Beaver Bay; and to the red (often quartzless) rock associated with the gabbro at Duluth. These beds also constitute the red bluffs at Tischer's and New London, as well as the red rocks at Baptism river, and the eastern palisades. In a number of instances the bottom of this great red (metamorphosed) shale has been found to be a conglomerate.

(2.) The feldspar masses are of the same rock (geologically) as the Rice Point gabbro, and both are the result of copious, and perhaps one of the earliest, igneous outflows of the Cupriferous. The more copious the igneous outflow, the coarser the resulting crystalization and the higher the hills formed, as well as the purer the labradorite material. The later outflows derived fragments from the "clinker fields" and from the knobs of feldspar already formed, as they passed along; and when these had been covered by later sedimentation such sedimentary beds were also involved in the later upheavals and fusions. (V. No. 817.)

(3.) It seems as if an igneous outflow,—perhaps the great labradorite—was thrust laterally under the sedimentary beds that went to form the palisades, heaving up those beds, and sometimes fusing them, and mingling with them, as seen near New London and at Beaver Bay, though no such evidence can be cited to show the laccolite formation in later strata. (V. No. 521.)

It must be admitted that it is not at all certain that the labradorite outflow was the earliest, so far as the observations go. It is simply the most conspicuous, and seems to lie nearest the Huronian. Besides this it is still a question whether the green basaltic traps, as at the east side of Beaver Bay, and as that coming out from under the Great Palisades, or the melaphyr-like traps as at Petit and Grand Marais, can be shown to pass into the gabbro without the intervention of any change but difference of proximity to the center of outflow. It is probable that such a gradation can be shown. the rock at Knife River Point being an intermediate step, and that at Encampment Island another.

To illustrate the steps in the change from the feldspar rock to the gabbro, reference may also be made to several large masses lying in the water near the red bluff at the west point of Beaver Bay on the east side of the bluff.

817. Hardened shale, from a brecciated, semi-metamorphosed reddish conglomerate at Two Harbor Bay, lying immediately over the Two Harbor rock, and immediately under heavy green doleryte containing masses of feldspar, (V. No. 525.) This shale is charged with laumontite. Certain blotches are charged with it, particularly in the

form of amygdaloid, the cavities being about one-fourth inch, and less, in diameter. The blotches, or spots, make up sometimes the most of the rock. They are without any order of arrangement. Intercallated amongst them are laminated patches and seams of red material which is fine-grained, and was probably a shale at first, disseminated amongst a coarse conglomerate in the same manner as shale is often seen disseminated throughout a conglomerate, (as at Manitou river); the laminae being parallel with the general dip. Of this conglomerate breccia thirty-five feet are to be seen.

The bottom of the overlying trap is a perfect pudding-stone of pieces of gabbro and feldspar masses. The largest mass of "feldspar rock" at the point east of Two Harbor Bay shows a bedded, at least a banded, structure running nearly perpendicular from top to bottom, similar to that described east of Beaver Bay (No. 814.) It is crossed obliquely by an old dyke, which dyke is faulted, about midway of the bluff, about two feet. A small dyke also runs near the water about horizontal, derived from the trap at the left which, near the water, seems to run below the feldspar. This lower part of the trap holds a piece of the red syenite, near the water level.

As to the "Two Harbor rock," its character and origin are still to be determined by more minute examination of the samples collected, and by further field observations. It has been referred to as a metamorphic rock, in some of these notes, but it has also very much the aspect of a fine-grained, igneous rock. It has the jointage, as well as the general homogeneity of trap, and the red bands crossing it, and the geodic spots seen on its surface, perhaps, have originated from the overlying sedimentary conglomerate. It does not have the appearance of being, exactly, the equivalent of the quartzless red rock at Duluth, but it must occupy very nearly the same stratigraphic position.

818. On the east side of Splitrock Point is a grand pudding-stone of feldspar, gabbro and dark-trap masses cemented still by a dark trap. The most of the so-called feldspar here is really gabbro, very much like the Rice Point rock. This number is from such gabbro-like pieces.

East of this point, but within the same bay, are feldspar masses that show the green banding or bedding. The bands run nearly perpendicular. The lighter-colored bands are much more coarsely crystalline than the darker, which is also true at the point two and a half or three miles east of Beaver Bay, (814.) This is also cut by dykes and generally mingled with the matrix of dark trap in great confusion.

819. From the top of the high hill back of Silver Creek—the high-

est hill near the mouth of the creek, yet on the west side, rising 415 feet above the lake, though at a mile further back it rises perhaps 150 feet higher.

At Flood Bay (next east of Burlington Bay) are frequent slabs of laumontitic sedimentary shale strewn on the beach on the east side. They are at the same time sandy, of a brick red color, with spots of lighter red, and of green, like the Fond du Lac sandstones The amygdules consist of calcite and laumontite, but principally the former. Some of these slabs have distinct markings of fucoidal stems, some of them being large and long. As these slabs are evidently from the formation that forms the shore line generally, though where they are found no rock bluff is exposed, they unmistakably prove the sedimentary origin of the red laumontitic amygdaloids so common on the north shore. in another line of evidence.

820. Trap rock, at the railroad cut, Taylor's Falls. This is crystalline, tough, greenish with that internal structure that Prof. Pumpelly assigns to melaphyr, i. e. there are almost imperceptible forms of crystals that permeate the rock, and are so completely filled with the other constituents of the rock that they do not appear distinctly till the rock is weathered. They are generally about one-third or one-fourth inch in diameter, but they do not show any angles, and they do not have the color of pyroxene. When they are distinctly brought out they are seen as spots that completely speck the face of the bluff. They disintegrate more rapidly than the rest of the rock, sometimes assuming a green chloritic character that causes them to make little pits as large as a pea all over the surface, due to the more rapid removal of this green mineral; and sometimes they become gray gradually, giving the appearance of nodules of siderite disseminated through the whole.

821. Shows the green-weathered spots of the rock No. 820. The change to the geen mineral takes place at depths of ten to twenty feet below the surface, in the railroad cut.

822. Shows the gray-weathered spots of the rock 820. This takes place nearer the natural surface of the ground, and at the surface.

In No. 820 are seen sometimes small pebble-like lumps of red jasper, and larger deposits of chalcedony, the latter sometimes being elongated lenticularly, some like gash veins, four or five inches The chalcedony also appears as pebble-like masses and as filling to scattered cavities somewhat in the manner of amygdaloid. Coating the joints, which are often slickensided, is frequently a green slippery mineral like delessite. Sometimes the chalcedony is more pure quartz, and is mingled sparsely with calcite. These characters are those of an igneous rock, and at the same time this rock differs quite distinctly from the gabbro at Duluth. The jasper and chalcedony recall the disseminated red jasper and quartz pebbles of the conglomerate at Ogishke Muncie lake

823. Pebbles from the conglomerate forming the lower part of the bluff excavated by the railroad where it crosses the highway south of Taylor's Falls. The bluff here is red-spotted and composed of a curious, coarse, conglomerate. It is dark-colored generally, looking some like the trap formation about Taylor's Falls, but the jointage and the texture are different Some of the surfaces are variegated with coatings of green, radiated malachite, and some are stained green without showing evidently the mineral producing the color. Some also are nearly black and some jasper-red. It is in some spots coarsely vesicular, or like pumice, or like amygdaloid. The amygdules received quartz at first, (as shown by the perfect terminations of crystals) and subsequently calcite and chlorite. Some of it is hæmatitic, and has a streak of red. It was here evidently a shale-conglomerate, but it has the appearance of having been heated and hardened, as well as mixed perhaps with igneous matter. In some places it is fine and crumbles like a dry shale. In some places its conglomeritic composition appears on weathering, the little rounded pebbles (of hardened shale, or of fine argillaceous quartzyte), rolling out entire. The pebbles have a great resemblance to the rock itself, but there are none of quartz. They are somewhat changed by decay.

824. The upper portion of this bluff consists also of a curious conglomerate, the matrix of which is represented by this number. It is a completely crystalline dolomite (apparently, though not yet analyzed) which effervesces in acid when powdered, and which contains fossils of *Lingulæ* &c., and nodules of course calcite crystals. Every grain is a perfect crystal; but in the upper part of the bluff this matrix becomes free from pebbles, and forms beds of dolomite like that seen in numerous other places along the St. Croix valley.

825. The great bulk of this upper portion is made up of boulders contained in No. 824, of which 825 is a sample. They have been said to have come from the "trap" of the region, and perhaps they do, but they are not like the rock 820. They are sub-angular and somewhat rotted. They are porphyries, of a green color, (now) or are homogeneous, resembling some of the rock seen in the Huronian. It is in these boulders that the green coatings of malachite are seen.

This conglomerate, which has its lower portions quite different from the upper, can hardly be separated into two by any distinct line of superposition. The matrix of the upper portion runs below parts that resemble, and indeed are the same as the conglomerate of the lower, while some masses above, embraced in this matrix, seem to be like the underlying conglomerate, and crumble in the same way. The lower characters occupy a thickness, visibly, of six feet, at the highway crossing, though in ascending the hill toward the north, it probably increases, while the upper characters have a thickness of probably 75 feet, rising to the top of the hill further north. Yet this interval is not all visible.

826. At the top of the hill north from the last, in front of Mr. Folsom's house, the rock 820 shows an alternate banding that resembles stratification, and would ordinarily be taken for that. This is seen over the surface of one or two square rods. The rock in general here is smoothed off by glaciation, and this character comes out distinctly on the planed surface. It is less coarsely pitted by the weathering out of the invisible crystals than at the R. R. cut. Indeed the banding that simulates that of sedimentation, consists in finely pitted belts on the surface of the rock alternating with non-pitted bands. The dip, if this structure be due to original sedimentation, is N. E. about 45° in amount, as evinced by a thin layering that slopes in that direction, and which has a tendency to split in beds from one inch to six inches thick coincident with this banding. The rock here also contains chalcedony nodules and is scatteringly porphyritic, resembling thus the pieces found in the upper portion of the conglomerate, No. 825.

The rock that forms the rapids in St. Croix river, half a mile above the town of Taylor's Falls, is essentially the same as that in the R. R. cut, but is less coarsely and conspicuously pitted by the weathering and decay of the invisible crystals supposed to be pyroxene. It is more frequently supplied with quartz, either white or chalcedonic, than the other, and is also striped with red granite, or at least with a red mineral in blotches and vein-like deposits like flesh-red orthoclase, which is also mingled with white quartz. Along the river gorge this rock weathers and crumbles globuliferously, much like the trap-rock seen on the north shore. It has a course and irregular jointage, and sometimes a conchoidal fracture. It is not truly basaltic, even in the Dalles, like the basalt of Grand Marais; yet there are in some places frequent perpendicular joints that divide it into columns. These are cut nearly horrizontally by other joints. Hence coarse columns result from weathering, which are broken horizontally into cuboidal or rhomboidal masses. The banding which looks like sedimentation, near Mr. Folsom's, does not appear generally,—indeed is not known to occur at any other place.

827. From the lower portion of the conglomerate, showing the contained pebbles and the matrix which seems to be of the nature of igneous rock, from the top of the hill east of the R. R. crossing of the highway.

828. Samples of the finer part of this conglomerate where the cement is not igneous, from the same place.

Concerning this conglomerate certain things can be definitely stated, viz:

1. It is extensive, and spreads widely northwestward, even rising to the tops of the hills toward the shaft sunk by Mr. Taylor. It appears in the street, and in the yard of W. H. Cummings, where it is so firm and bold in its outlines, as to appear to be of the real trap formation of the region.
2. It contains waterworn boulders and trap of the region, some of them being porphyries and some not, thus showing the agency of water in its origin.
3. The cementing material is, in the main rock, very much like the boulders, but finer-grained, and sometimes amygdaloidal, thus indicating a possible igneous agency in the origination of thhse parts.
4. It is coarser in its composition near the trap-rock outcrops than at a distance from them; yet the superposition of the conglomerate on the trap cannot actually be seen.

A short distance above Taylor's Falls, at an old quarry in the bluff of the river, the upper part of the conglomerate is so fine as to make a regularly bedded rock about twelve feet thick, and passes for a sandrock. It here contains *Lingulæ*, (*Discina?*) and an occasional small trilobite. Below it becomes coarser and embraces half-rotted pebbles and boulders from the trap. The matrix here also contains grit, some of the pebbles also being of quartz.

On the Wisconsin side the trap is in outcrop in a large ridge about four miles below Franconia, along the road to Osceola. At Franconia the sandrock runs down to the level of the river; near the bottom it is greenish-blue and shaly, and sheds water. This shaly impervious stratum extends down the shore below Franconia, and is visible along near the water-level on the west side of the river, rising sometimes ten feet above it. On Lawrence creek, near the Franconia Mills, is a bluff which overhangs, on account of the crumbling out of the loose sand below. In the crumbling part are numerous laminations of bluish shale which cut the sand into lenticular beds or patches, and the sand itself is cross-bedded. In the crumbling sand are thousands of little *Lingulæ*, and *Discinæ*.

829. A mile and a half below Franconia is an isolated bluff, rising 45 feet above the river, composed of the curious conglomerate seen at Taylor's Falls. It here presents the same mingling of characters that may be referred to igneous and sedimentary origins. The great mass consists of trap boulders, considerably rotted, some of which are as large as a barrel. In the coarser portions of the conglomerate the cementing material is a finer conglomerate of pebbles of the same kind of rock, and in other portions it is a fossiliferous ferruginous, gritty or magnesian sediment, the fossils of which are the same as those seen in the crumbling sand at Franconia, and sometimes apparently an amygdaloid. The change that has taken place in the original structure of the conglomerate by partial decay, and perhaps by heat, makes it often difficult to distinguish between the pebbles and boulders, and the cementing material. The lower portions, if any, are those that seem to have been cemented by the action of heat. A specimen was here obtained of an amygdaloidal part (of the cement ?) which contained fossil shells within less than half an inch of the amygdaloid, both of which, were it not for the contradiction involved, would be pronounced to belong to the cementing material.

In conclusion, judging from the facts here recorded, this conglomerate shows evidences of some kind of metamorphic action in its lower portions, but the phosphatic shells penetrate far down into it and occur even amongst the metamorphic characters. The evidence that this conglomerate was formed under water, even its lower portions, consists in the rounded forms of the contained boulders, while the aqueous conditions of the upper portions are plainly shown by the shells, and by the fact that further up in the formation it graduates to a fine conglomerate and to dolomitic sand rock. (Samples 829 represent some of the finer portions of the conglomerate.)

830. At Sioux Falls, Dakota, may be seen a light-colored schist, of a talcose character, and pea-green color fading to nearly white, similar to that seen at Baraboo in connection with the quartzyte bluffs. It here lies in the rock and becomes a white catlimite. Below the present level of the water of the dam, but formerly exposed above the water, is a layer of white, or pinkish-white catlinite, four feet thick, embraced in the rock that produces the falls.

831. Samples of spotted-red quartzyte, like that at Sault Ste Marie, Michigan, and like some parts of the Fond du Lac sandstone, showing a probable identity of the geological horizons at those places. It is

possible that these light-colored spots are caused by the absorption of the iron through chemical change, and that by careful examination the cementing material would be found to be feldspathic.

The red quartzyte formation at Sioux Falls dips 6 to 8 degrees to the south. The beds are purple within, especially the thick ones, but toward the outside, and along the joints, they are changed in color to a rose red, or a pinkish red. None of the brick-red, heavily iron-stained color can be seen. The change that takes place by weathering not only changes the color but also the hardness, so that the rock goes into a loose sandrock again and crumbles in the hand. This takes place to so large an extent that in suitable places it is gathered and used for mortar. There are also some beds that are wholly now, (so far as can be seen) in this friable condition. The sand that results is a pure selica, nearly white, and translucent, though it is apt to show at first a slight pinkish tint rising from the remains of the cement among the grains. There is visible here, of the bedding, fifty feet, (estimated) and the river goes over the beds from south to north, producing a fine water power. In one place there is a gorge fifteen feet high and from seventy-five to eighty feet wide.

832. Spotted (amygdaloidal ?) samples of the brick-red quartzyte from Redstone, near New Ulm.

833. Red shale, the lowest rock seen in the R. R. cut at Redstone. This is four or five feet thick, the upper portions being rather slaty and tough. Some of the higher layers are sandy from disintegration as at Sioux Falls, and some are hard and quarzitic, and all are of a darker red color. Some beds are spotted, perhaps from an incipient amygdaloidal structure. Mr. Nicholas Thinnes, who first opened the quarry at Redstone in 1857, avers that some of the rock of the formation here is "granit," the same as some of that at Little Rock, a fact which, if verified, will unite the formation with that, and will show its analogy to those tilted red semi-crystalline beds in the northern part of the state (V. Nos. 783 to 785.) But this crystalline structure has not been seen at Redstone by any member of the geological survey.

834. Slab of red quartzyte from Sioux Falls, showing the finely pitted exterior of the individual sand grains on the removal of the white schist, No. 830.

835. Gray, coarse-grained granite, in color much like the gabbro at Duluth, from the E. St. Cloud quarries. This was formerly used in connection with the rocks 803 and the finer grained gray granite like that at Sauk Rapids indiscriminately for construction, but owing to its large content of quartz, it has been abandoned for those varieties

more easily wrought. All these sorts are to be seen in the trimmings of the Custom House at St. Paul. But that now generally used is to be seen in the trimmings of the New Union Depot, at the same place.

836. The pink quartzyte known as the "jasper rock" locally, from Sioux Falls, Dakota. This is a pinkish granular quartzyte, but with a cement that, on disintegration, allows the rock to become a white sand.

III.

THE POTSDAM SANDSTONE.

It is well known that geologists are not agreed on the question: "What is the western representative of the Potsdam sandstone of New York State?" The correct determination of this interesting problem has an important bearing on the interpretation of the stratigraphy of Minnesota geology, inasmuch as all the different horizons involved in the investigation are widely represented in the State. Those horizons are as follows in descending order:

1. The light-colored sandstones seen in the Mississippi river bluffs, and the bluffs of the St. Croix, from Taylor's Falls to Winona, containing species of *Lingulœ* and trilobites, generally distinguished by this survey as the *St. Croix Sandstone.*

2. The red and light-colored horizontal sandstones that bound the south shore of Lake Superior throughout most of Wisconsin, and much of Michigan, extending from Sault St. Mary to Fond du Lac, holding fucoids and *Scolithus.*

3 The red sandstones and shales, with the associated conglomerates that are involved with the trap-rocks of Lake Superior, furnishing metallic copper, lately known as the *Keweenian formation.*

At different places Nos. 1 and 2 have been seen unconformably overlying portions of No. 3, and in others No. 3 has been seen passing into No. 2, or at least into a sandrock that was taken for No. 2, while No. 2 itself seems to be the equivalent of beds that in other places represent No. 1.

While it is perhaps impossible at this time to state which of these three, or which two of these three, have the greater amount of evidence in their favor, it will conduce to the progress of the investigation to ascertain and collate some of the facts that bear on the geology of this disputed terrane, and to review briefly the progress of opinion and investigation in the Lake Superior region. In the light of late explorations in the West, and of late investigations in the East, perhaps it will be possible to reach more nearly a correct conclusion than at any other time. In the first place it will be well to summarize the opinions held by different geologists who have expressed any opinions respecting the Potsdam sandstone of the West. There was a school of geologists between 1840 and 1858 who regarded the Lake Superior sandstones as not of the Lower Silurian, and some are found even to this day. They were not united among themselves, but were divided between Jurasso-Triassic, Devonian, Upper Silurian and Carboniferous. After the investigations of Dr. D. D. Owen and the report of Foster & Whitney, unprejudiced geologists very generally accepted the conclusion that they are of the Lower Silurian, and lately the facts recorded by Dr. C. Rominger seem to place their Lower Silurian age beyond doubt. Thus the question is brought within narrower limits and the doubt that still exists pertains only to their exact horizon in the Lower Silurian, or in other words, where in the West the Potsdam sandstone is found. It was until lately that the same uncertainty existed within the limits of an individual State, respecting the equivalency of beds in the Carboniferous age as they extended from one side to the other,* and the problem was finally settled by tracing a well-known sandrock formation from north to south, and bringing all the other strata into order above and below it. Perhaps some such process may be applied to this question.

But before entering upon that a glance may be taken at the various opinions that have been held. These opinions may be grouped under sixteen heads, but the present state of knowledge compels us to ignore many of these opinions, which reduces the groups to be considered to ten. The sixteen groups are as follows, with the names of those who have advocated them:

Summary of Opinions.

1. Those who regard No. 1 as the Potsdam sandstone -**Logan, White.**
2. Those who regard No. 2 as the Potsdam sandstone—**Logan, Brooks.**
3 Those who regard No. 3 as the Potsdam sandstone—**Rogers (W. B.), Dana,** Winchell (N. H.).
4. Those who regard all of them as the Potsdam sandstone—**Hall, Foster, Whit**ney, Winchell (A), Dana, Kloos, Owen.
5. Those who regard Nos. 1 and 2 as the Potsdam sandstone—**Whittlesey Cham**berlin, Irving
6. Those who regard Nos. 2 and 3 as the Potsdam sandstone—**Hubbard, Rivot,** Rogers (W. B.), Whittlesey, Marvine, Rominger, Wadsworth.
7. Those who regard the Lake Superior sandstones as **Calciferous and Potsdam** —**Dana.**
8. Those who regard the sandstones of Lake Superior as **Calciferous—Dana.**
9. Those who regard the Lake Superior sandstones as **Potsdam, Calciferous and** Chazy—Logan.

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*Ohio.

10. Those who regard the Lake Superior sandstones as Quebec—Logan, Hunt, Pumpelly, Dana, Hall.

11. **Those who regard the Lake Superior sandstones as Jurasso-Triassic—Houghton, Ruggles, Jackson, Shepard, Rogers (H. D.), Owen, Marcou, Dana, Bell (or Permian).**

12. **Those who regard the Lake Superior sandstone as Upper Silurian—Jackson.**

13. **Those who regard the Lake Superior sandstone as Devonian—Locke, Bigsby and Bayfield.**

14. **Those who regard the Lake Superior sandstones as Permian MacFarlane.**

15. **Those who regard the trap and sandstones of No. 3 as Cambrian—Logan, Bigsby (Whittlesey older than No. 1).**

16. **Those who regard the trap and sandstones of No. 3 as Huronian—Selwyn.**

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Opinion No. 2. Geological survey of Canada. Rep. for 1846-7; American Journal of Science, 1852, XIV, 226; Geology of Wisconsin, 1873, III, 433.

Opinion No. 3. Proc. Bos. Soc. Nat. His., 1860, VII, 394; Rep. Minn. Survey, 1872, 68; *Ibid* 1876, 29; Dana's Manual of Geology, edition 1862, p. 173 74.

Opinion No. 4. Palæontology of New York III, 79; Report on the Geology of the Lake Superior Land District, Part II, p. 137; Proc. Am. Assc. Adv. Sci., 1851, V., 22-38; Am. Jour. Sci., 1864, XXXVII, 226; Sixteenth Regents' Report N. Y. State Cabinet, p. 119; Dana's Man. Geol., 1862; Geologische Notizen ans Minnesota, Zeit. d. deut. geol Gesell, 1871; Owen's Report on the Geology of Wisconsin, Iowa and Minnesota, 1852; Proc. Am. Assc Adv. Sci., 1855, X., 204; Leonhards' Jahrbuch, 1877, Erstes Heft, pp. 31, 113, and 225.

Opinion No. 5. Geology of Wisconsin, 1873, III; Geol. Wis., Iowa and Minn , 461.

Opinion No. 6. The Mineral Regions of Lake Superior, by J. Houghton, Jr., and T W. Bristol: Senate Documents, 1849-50, 31st Cong., 1st Sess , III, p. 802, 842; *Ibid*, 1845-6, 29th Congress, 1st Sess., VII No. 357, p. 2-29; Annales des Mines (5) 1855, VII, 173; 1856, X, 364; Proc. Bos. Soc. Nat. Hist., 1860, VII, 394-399; Proc. Am. Assc. Adv. Sci., XXIV, 1875, 60; Mineral Regions of Minnesota, 1866; Geology of Michigan I, Part II, 1873; *Ibid* Part III: Proc. Am. Assc. Adv. Sci. XXIX, 429.

Opinion No. 7. Dana's Man. Geol. 1862, pp. 172-74.

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Opinion No. 11. Am. Jour. of Sci. (1), XLIX, 62-72; *Ibid*, p. 81-93; Assc. Am. Geol. and Nat., 6th meeting, 1845, p. 53; Bul. Soc. Geol. France, 1850-51 (2), VIII, 101; Geology of North America, by Jules Marcou, Zurich, 1858, p. 64; Rep. on

Chip. Land Dist., 1848, pp 57-58; Sen. Docs., 1847-48, VII, No. 57, p 134; Am. Jour Sci., 1843 (1), XLV, 160; Proc. Bos. Nat. Hist., 1864, II, 124; Dana's Manual of Mineralogy, 2nd Ed., 1857, p. 305; Rep Progress Geol. Sur. of Can., 1866-69, p. 321.

Opinion No. 12. Proc. Bos. Soc. Nat. Hist , III, p. 335.

Opinion No. 13. Quar. Jour. Sci. Lond., 1824, XVII, pp. 1-34, 228-269; Am. Jour. Sci., 1824 (1), VIII, 60-88; Trans. Lit. and Hist., Soc. of Quebec, 1829, I, p 1; Locke's Beport, 1847.

Opinion No. 14. Can. Nat and Geol. (2), III, p. 256.

Opinion No. 15. Trans. Brit. Assoc. Adv. Sci., 1851; Edin. New. Phil. Jour. LIII, 55; Geol. Wis., Iowa and Minn., 461.

Opinion No. 16. Can. Nat. and Geol. (2), IX, 17; Rep. Prog. Can. Geol. Sur., 1877-78.

If we discard those whose opinions make the Lake Superior sandstones post-Silurian, and also those who regard them as pre-Silurian, of the remaining, by far the greatest weight of authority falls on proposition No. 6, which assigns Nos. 2 and 3 to the Potsdam. Proposition No. 4, which assigns them all to the Potsdam, follows next in weight of authority.

In this enquiry it will be necessary in the first place to ascertain exactly what the Potsdam sandstone is stratigraphically, lithologically and palaeontologically. This will involve an enquiry into the nature of the formations that lie below and above it in New York and New England Secondly, it will be necessary to ascertain what formations in the West approach most nearly to an equivalency with the same horizons.

1. What is the Potsdam of New York and New England? As to the lithological characters of the Potsdam in New York the following is from the annual report of Dr. E. Emmons, Jan. 1838: "This rock is a true sandstone, of a red, yellowish-red, gray and grayish-white colors. It is made up of grains of sand, and held together without a cement. Inter-mixed with the siliceous grains are firner particles of yellowish feldspar which do not essentially change the character of the sandstone, but show the probable source from which the materials forming it were originally derived, viz.: some of the varieties of granite. Unlike, however, most of the sandstones, it is destitute of scales of mica. The coloring matter of the rock is evidently oxide of iron, but unequally diffused through it, giving it intensity or deepness of color according to its quantity. In some places it is almost wanting, which makes it, when pulverized, a good material for glass. The grains and particles in its composition are generally angular, but where it takes the character of a conglomerate, as it does in the inferior layers, they are frequently rounded. The thicker strata exhibit an

obscurely striped appearance, owing to the prevalence of certain colors in the different layers." In his final report on the agriculture of New York Mr. Emmons says of this rock: "This sandstone is more uniform in its characters than most of the individual rocks in the series. At Potsdam it is yellowish-brown; at Moira and its neighborhood, and also in Mooers, it is nearly white and sandy; at Chazy it is of a deep red at the bottom, and gray towards the top, while at Whitehall, Corinth, Hammond and near Glen's Falls it is gray, and more or less crystalline. In many places it is a coarse conglomerate, as at Mooers in Franklin county, and at DeKalb in St. Lawrence county. It is of course a siliceous rock, yet it does not exclude other substances or elements; for, a true sandstone, far from being composed of pure siliceous sand, admits into its composition mica and feldspar, oxide of iron, and probably even a greater variety of the primitive minerals, as hornblende, pyroxene, &c., in a state of fine division."

Mr. Mather, in his final report on the first district, speaks of the Potsdam in the following terms: "The Potsdam sandstone is a hard siliceous sandstone, white, red, gray, yellowish, and frequently striped. It is well developed at Whitehall." * * * * "Some of the strata of this rock are covered with the most beautifully characterized ripple-marks, as perfect as if just formed on the sand of a sea beach, while the rock is of the most indurated kind of sandstone." * * * * "Fucoidal impressions are also seen in some of the strata of this rock. * * * * "It is a hard stone to dress, and is one of the most durable kinds of rock." * * * * "In some places, in its lower part in particular, it is a metamorphic rock, having more or less the aspect of gneiss, except that mica is absent. Half a mile west of Putnam's Ferry, where it overlies granitic rocks, it is in an intermediate state, having the general aspect of a primary rock, but still shows its rounded gravel and sand." Mr. Mather mentions other places where it has been changed by metamorphic agency. In the northwest part of Clinton county, and in St. Lawrence and Franklin counties the lower portion of the Potsdam is a conglomerate, which in some places reaches the thickness of 300 feet.

Where the formation appears in Vermont it runs in mono-clinal, long or short, sharp ridges, and is thus spoken of by Dr. Edward Hitchcock in the first volume of the final report on the geology of Vermont, 1861: "Its lithological characters vary very little. In consequence of a metamorphic action we reckon three varieties:

1. Pure siliceous sandstone.
2. Hornblende schist.

3. Gneiss.

"The first of the trio is what is universally known as Potsdam sandstone, a hard, compact, thick-bedded sandstone, and perfectly homogeneous in structure, unless metamorphosed. Its color is generally white in the eastern part of North America; it being red upon the shores of Lake Superior." * * * "The second variety cannot be distinguished from the hornblende schist which occurs among the azoic rocks of Vermont and New York." * * * * "The third variety very closely resembles the Laurentian gneiss. It seems to pass into it by insensible gradations. All the constituents of this rock are very small, and occasionally the feldspar or the mica may be wanting. These hornblende schists and gneiss rocks, indicate a change has passed over a part of the Potsdam sandstone, analogous to the metamorphism that has so obscured the rocks of eastern Vermont; for such rocks as gneiss, &c., are not found, except by the crystallization of the constituent minerals after the accumulation of the sediments." Dr. Hitchcock also mentions veins of "granite" in the Potsdam at West Haven, whose feldspar is labradorite. At the time of Dr. Hitchcock's report the "red sandrock" of Vermont was not admitted within the Potsdam, nor was the "quartz rock" running along the western base of the Green mountains, but an earnest discussion was then going on between Professors Hall, Dana, Emmons, Marcou, Billings, Logan and others, concerning the geological position, and the actuality of any such system as had been designated Taconic, claimed by Prof. Emmons to lie directly below the Potsdam: *Vide* Am. Jour. Sci , 1861, No. 91; and Can. Nat. and Geol., 1861, Vol. VI, p. 106.

2. As to the palæontology of the New York typical potsdam. Prof. Hall reports in the first volume of the palæontology of New York, besides *Scolithus linearis*, two spieces of *Linguləe*, viz: *prima* and *antiqua*. To this list have been added since a species of *Hyolithes* from Keeseville. Am. Jour, Sci., July 1871, p. 32; 1873, p. 211, vol. 5; imperfect specimens of supposed *Pleurotomaria* and *Conocephalites minutus*, from Keeseville. The last may belong to the beds below the Potsdam, as described by Brooks, Am. Jour. (3) IV, 22. In the state of Vermont have been discovered several species of trilobites, as well as other species of trilobites and brachiopods at Troy, N. Y., (Am. Jour. Sci., 1873, vol. VI, p. 134; vol. XI, 1876, p. 369.) But as their position in the formation is still in doubt, while some of them, especially those from Georgia, Vt. and Troy, N. Y., have been shown to belong below the Potsdam in statigraphical sequence, none of them should be embraced in the fauna of the typical Potsdam. At the same time the term Potsdam

has been extended loosely over these strata, especially by those who are adverse to the Taconic group of Emmons. (Am. Jour. Sci., 1880, vol. XIX, p. 152; Ibid, 1880, vol. XIX, p. 153 and p. 225.)

3. One of the results of the Taconic discussion was the establishment of the essential correctness of Prof. Emmons' claim, that beneath the Potsdam sandstone was still a fossiliferous horizon, which when metamorphosed constituted the roofing slates and talcose rocks of eastern New York and northern Vermont, though he perhaps extended it without warrant over areas where he had not sufficient evidence of its actual continuance. This error however, no more invalidated his claim to the correct establishment of his system than a similar supposed error in the extension of the Hudson River rocks where they were not proven to exist in Vermont, Massachusetts and eastern New York, destroyed that system. Geol. Wis., 1862, p. 443; Proc. Am. Ass. Adv. Sci., 1877, XXVI, p. 259. The palæontological investigations of Mr. Billings, seconded by Mr. Barrande, and of Mr. Ford, have amply demonstrated that beneath the horizon of the Potsdam sandstone is a series of rocks containing a primordial fauna, consisting of argillaceous slates, black slate, and thin-bedded sandstone with some limestone. This formation, sometimes known as the Georgia Group, is probably the equivalent of the Acadian of Dawson. According to Broo[illegible] these strata, as they occur at Keene Station in St. Lawrence Co., N. Y., consist of magnesian schists, crystalline limestone and sandrock like the Potsdam but containing beds and veins of granite, the whole amounting to a mininum thickness of 700 feet, (Am. Jour. Sci. (3) IV. 22.)

4. The fossil species, described by Mr. Ford from these lower Potsdam, or Taconic rocks near Troy, N. Y., are sixteen, and a portion are identical with fossils from the Acadian. On the strength of palæontological differences Mr. Ford states that he considers these beds to occupy a lower geological horizon than the typical Potsdam of New York, and to be of nearly, if not exactly, the same age as the Georgia slates of Vermont, and the limestones on the north shore of the straits of Belle Isle. The fauna he regards "wholly distinct specifically from that of the upper Potsdam of Wisconsin and the true Potsdam of New York," (Compare Am. Jour. Sci., (3) XIX, 152.) After Mr. Barrande had indicated the primordial character of the trilobites of the Georgia slates, and Messrs. Billings and Logan had accepted his suggestion. Prof. Hall also recognized the strength of palæontological authority and admitted that the Potsdam of the New York survey was not the true primordial base. This true primordial zone is

characterized in America by such trilobites as ***Paradoxides, Conocephalus***, *Arionellus, Conocoryphe*, and *Olenellus.*

5. If we next inquire what formation lies above the New York typical Potsdam, we shall find the Calciferous Sandrock described by Prof. Emmons as follows:—(Final Rep.) "Considered as a totality this is one of the most heterogeneous rocks in the New York system. That part which furnished the name is well designated under the descriptive term, and is easily recognized." This is a gray mass with sparkling grains of lime, but an impure limestone, being mechanically mixed with fine grains of sand and slight interlaminations of argillaceous matter. Another variety is a fine-grained and blue limestone, and another is red or chocolate colored, consisting of sandstone slightly interlaminated with shale.

Mr. Mather thus designates this formation: "The rocks are calcareo-siliceous, and sometimes one and sometimes the other predominates, and gives character to the rock. The water-lined laminæ of deposition are very conspicuous in some of the strata of the Calciferous sandstone. * * * * There are numerous small patches where these rocks have been upheaved and exposed, that are not continuous for any considerable distance * * * *, having been fractured across and heaved out of place along faults transverse to the lines along which the *principal* disturbances have taken place." This formation in N. Y. lies under the Chazy limestone.

6. The fossils of the Calciferous in New York, as reported by Prof. Hall in the first vol. of the palæontology of New York consist of the following:

Two species of *Palœophychus.*

One species of ***Buthotrephis, Lingula acuminata, Euomphalus uniangulatus.***

Two spiecies of *Maclurea.*

Two species of *Ophileta.*

Two species of *Turbo.*

Pleurotomaria turgida.

Two species of *Orthoceras.*

To these Mr. Billings has added very many species from the adjoining portions of Canada, including gasteropods, brachiopods, and cephalopods. Of trilobites are fourteen species referred to the Calciferous, viz.: two of *Amphion*, six of *Bathyurus*, one of *Asaphus*, and others of *Agraulos* and *Conocoryphe.* The rocks of the Quebec group, which are placed by Prof. Dana above the Calciferous, seem to embrace both stratigraphically and palæontologically, the whole range of beds from the base of the *second fauna* to the top of the Chazy; and over two hundred and twenty species have been described from this group. But their relation to the Potsdam is still a matter of doubt. While stratigraphically they are placed above the Potsdam by Billings, Logan, Dana and Hall, they still have many of the species that have been reported from the western so-called Potsdam, viz.:

Four species of *Leptæna.*
Fourteen species of *Orthis.*
Three species of *Lingula.*
Two species of *Obolella.*
Two species of *Stricklandia.*
Two species of *Ecculiomphalus.*
Seven species of *Pleurotomaria.*
Two species of *Murchisonia.*
Three species of *Ophileta.*
Two species of *Holopea.*
Seven species of *Metoptoma.*
One species each of *Helicotoma* and *Maclurea.*
Seven species of *Orthoceras.*
Six species of *Cyrtoceras.*
One specie of *Nautilus.*

TRILOBITES.

Three species of *Agnostus.*
Two of *Arionellus.*
Two of *Asaphus.*
Eight of *Bathyurus.*
Two of *Cheirurus.*
Eight of *Dickelocephalus.*
Three of *Menocephalus.*

And one each of *Amphion, Amphyx, Conocephalites, Holometopus, Illænus, Nileus, Shumardia* and *Leperditia.* Mr. C. D. Walcott has also lately found the following new species in the Calciferous in Saratoga county, New York, viz.: *Platyceras minutissimum, Metoptoma cornutaforme, Conocephalites calciferus, Conocephalites Hartii, Ptychaspis speciosus* and *Bathyurus armatus,* of Billings He remarks that "the occurance of a species of the genus *Ptychaspis,* associated with *conocephalites calciferus* and *C. Hartii*—species related to *Conocephalites Wisconsensis* and *C. Iowensis* of the Potsdam fauna of Iowa and Wisconsin—relates the fauna of the Calciferous formation of New York with that of the Potsdam sandstone of Iowa and Wisconsin."

We have now stated the essential features and the stratigraphical position of the typical Potsdam sandstone of New York, as given by the best authorities, and it will be best to recapitulate briefly.

1. It is a red or gray loose sandstone, often tilted or faulted, also metamorphozed, and then having the name of quartzyte.
2. It contains but very few fossils, three undoubted species being the most that can be referred to it, but not distinctly primordial.
3. It is underlain by a series of black slates and sandstones, with some limestones, which have exhibited in Vermont, at Troy, N. Y., and at the Straits of Belle Isle, a decidedly primordial type of life.
4. It is overlain by a formation which exhibits but few fossils in New York, but which in Canada holds a diversified fauna, placed by Barrande, Billings and Logan near the bottom of the second fauna, containing, among other species, numerous genera of trilobites.

If in the same manner the formations of the Lower Silurian in the west that may possibly be the equivalents of these three of New York, be reviewed, some light may be thrown on the question of the parallelism of the New York Potsdam in its western extension.

1. The lowest formation known in the northwest, which may be parallelized with the foregoing, is that which Sir William Logan denominated at first the "Lower Volcanic Group," and subsequently the "Kaministiquia Slates," and which Dr. T. S. Hunt has named the "Animikie Group." It is the same as that which contains the silver mines of the northwest shore of Lake Superior. It is briefly described in the Seventh Annual Report of the Minnesota Geological Survey. It consists emphatically of slates, but it contains many beds of gray quartzyte, and some of dolomite. It passes downward to the Gunflint beds of northern Minnesota, and *seems* to lie unconformably on the formation that has been accepted as the Huronian. It is cut by igneous dykes, and is interbedded with what appears to be a diabase rock. No fossils have been found in it. The slatiness of this formation is due to the horizontal sedimentary lamination, so far as seen, and not to a superinduced cleavage. The extent of this formation northwest of Lake Superior is unknown toward the north but it extends east and west at least one hundred and twenty-five miles. It is believed to occur in Michigan and Wisconsin, since mention has been made in geological reports of those States of a "black slate" in the Potsdam formation. Proc. Am. Assc. Adv. Sci., IX, 208; the Mineral Regions of Minnesota—Whittlesey, 1866, p. 4. Stratigraphically this seems to occupy the place of the Taconic rocks at Troy, N. Y., and of the Georgia Group of Vermont. Lithologically it has a close resemblance, and

palæontologically the evidence of parallelism is simply negative, *i. e.*, as no fossils have been found in it, no comparison can be made on that basis.

2. The foregoing formation is overlain by the Cupriferous rocks of Lake Superior (No. 3 above), whether conformably or not is not known, but so far as the evidence goes it appears in Minnesota to graduate into the overlying formation conformably, and unconformability is not reported by the Canadian geologists at Thunder Bay. This formation is pretty well known, so far as its associated igneous rocks are concerned, and the equivalency of its sedimentary portions with the Potsdam has been the subject of much discussion. A summary of opinions has already been presented. It is only necessary here to mention its outward characters, and to compare them with the three formations of New York, to each of which it has been referred by different geologists.

It is a red formation of shale, sandstone and conglomerate, metamorphozed by igneous upheaval and fracture, locally changed to gneiss, syenite and hard, red quartzytes, and is interbedded with dolerytе and mixed with gabbro. In it have been seen only the non-characteristic *Fucoides*, but its association with repeated igneous outflow is sufficient reason for the non-existence of animal life in the era of its deposition. Still if the sandstones of Tequamenon Bay in Michigan be considered its equivalent it may be said that two species of *Lingula* have been taken from this formation. Dr. Rominger, however, who has carefully examined the Upper Peninsula of Michigan, unhesitatingly places these in conspicuous formation, as he also does the bed of breccia containing the *Dikelocephalus* on the Menominee river near Grand Rapids —Geol. of Mich., vol, I, Part III, pp. 73 and 80. The beds at Marquette containing *Pleurotomaria* are placed by Mr. Billings in the Calciferous.

The lithological characters of this formation, therefore, ally it unmistakably with the typical sandstone of Potsdam, while stratigraphically it lies above a similar series of black slates and sandstones as in eastern New York and Vermont. If it be borne in mind that the typical Potsdam has a very meager fauna, consisting of but three species not characteristic of that horizon, it has a very close resemblance in its fauna also; and it is not unreasonable to suppose that when this horizon in the northwest has been as minutely examined as the typical Potsdam has in New York, an equal number of *Lingulae* may be found in it.

3. It is the overlying formation, however (Nos. 2 and 1), which af-

fords the best material for comparison with eastern rock horizons, as it is marked by a fauna very diversified and characteristic, and is easily traced, by a series of explorations by competent geologists, from the Mississippi river to Canada, with no very important interruptions, making a very close connection with an allied, if not an identical, formation in eastern Canada. Here are placed in one formation the foregoing Nos. 2 and 1, not because there is certainly any line of separation between Nos. 2 and 3, nor the absence of one between Nos. 2 and 1, but because on comparing the described characters of 1 and 2, they seem to occupy nearly the same geological horizon, and for the present purpose can best be considered as one. They consist of light-colored siliceous sandstones with some dolomitic layers near the top. They are horizontally stratified, and are seen in different places to lie unconformably upon the tilted layers and trap rocks belonging to No. 3—or the copper-bearing rocks. This is the case at Taylor's Falls, Minn., and at Kewenaw Point in Michigan. While it would perhaps be an arbitrary line which should set them off as a distinct formation from the copper-bearing series, they still need to be distinguished from that series on account of great lithological differences and stratigraphical position, as well as on account of the rich fossil fauna they have afforded. The fossils that have been described from the bluffs of the Mississippi and St. Croix rivers by Dr. Owen (Geol. Wis, Iowa and Minn.) and by Prof. James Hall (16th Regents' Report) are all from this formation, and it requires but a glance to see their resemblance to that fauna which has been found in Canada and described as in the Quebec group. These fossils, as enumerated by Prof. Hall in the 16th N. Y. Regents' Report, are as follows:

Five species of *Lingula.*
One species of *Lingulepis.*
One species of *Discina.*
One species of *Obella.*
One species of *Orthis.*
One species of *Platyceras.*
One species of *Euomphalus.*
One species of *Theca.*
One species of *Serpulites.*
One species of *Sendrograptus*
And of *trilobites* the following:
Six species of *Dikelocephalus.*
Eighteen species of *Conocephalites.*
One species of *Arionellus* (?).

Three species of *Ptychaspis.*
One species of *Chariocephalus.*
One species of *Illaenurus.*
One species of *Triarthrus.*
Three species of *Agnostus.*
One species of *Aglaspis.*
One species of *Pemphigaspis.*
One species of *Amphion.*

With such an array of identical genera, not to say species, it is safe to assume identity of geological era for these strata with those containing such a fauna in Canada—Pal. Fossil, p. 198; Am. Jour. Sci. (2,) XXXI, 222. It is to be admitted that these fossils have not yet been discovered in the arenaceous strata extending through northern Michigan, although the same friable formation, occupying the same stratigraphical horizon, extends from Wisconsin to the east end of Lake Superior, and has been traced by Prof. Chamberlain and Dr. Rominger. They are there kept constantly distinct by Dr. Rominger, from the underlying red sandstones, which he says are generally firm, and become disturbed by igneous upheavals in their lower portion. The sandrock, cut by the canal at Sault St. Marie, he says is the lower red sandrock.[*]

To what eastern formation this fossiliferous belt may finally be assigned, whether to the Quebec or to the Potsdam, it certainly shows the palæontology of the Quebec; but at the same time Prof. Hall has cautiously assigned it to the Potsdam of New York. He has also assigned the sandstones of No. 3 and No. 2 to the same, and his authority, therefore, to a great extent, nullifies itself.

It seems, therefore, that so far as present available information will warrant us in coming to a conclusion, we can accept the following as probable if not certain:

1. The Taconic Group was correctly established by Prof. Emmons, though its limits, stratigraphically and geographically, were at first wrongly defined by him.[†]
2. The Georgia Group of Vermont, and the Animikie Group of Thunder Bay, and the Acadian of New Brunswick, are the equivalent of the Taconic of Emmons.
3. The Taconic has the true primordial fauna of Barrande.

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[*] See Hunt on the identity of the Calciferous and Western Potsdam, Can. Nat. and Geol. (3) VI, 87; Azoic, Rocks of Penn. 1878. Report E., pp. 107 and 108.

[†] Compare Dana's investigation of the so-called Hudson River Group, in Mass., Vermont and New York. Am. Jour. Science, various papers in 1872—80.

4. The Potsdam, which lies conformably above it in the east, is represented by the rocks of the copper-bearing series in the west.

5. No fossils, representing the true primordial fauna, have yet been discovered in the west, nor have any been found in the western representative of the Potsdam.

6. The "second fauna" of Barrande is found in the Quebec group of Canada, and in the St. Croix sandstone of the west, lying in each case above the Potsdam sandstone.

IV.

TYPICAL THIN SECTIONS OF THE ROCKS OF THE CUPRIFEROUS SERIES IN MINNESOTA.*

By N. H. Winchell.

In northern Minnesota the cupriferous rocks, when crystalline, consist of two distinct types. One serie is *igneous*, and one is *metamorphic.*

The former may be broadly comprehended under the term *dolerytc*, as defined by Prof. J. D. Dana. The most frequent representative of this group is the rock gabbro, consisting essentially of labradorite, augite and titaniferous magnetite. It produces the dark-colored and heavy rocks of the shore, is seen as layers alternating with the non-crystalline and sub-crystalline layers of the other group, and as massive, mountain-like elevations. It is often basaltic. On weathering, it decomposes and becomes greenish when near the water, but brownish when at higher elevations. It is often amygdaloidal, furnishing various zeolitic and other minerals. It has a very intimate, and yet very distinguishable association with the rocks of the other group; but in general it is the most conspicuous rock of the cupriferous series, causing the most of the salient features of the coast, and the prominent elevations of northeastern Minnesota. When in contact with the sedimentary beds, the rocks of the igneous group are but slightly affected by the interpenetration of the minerals of the other group. Yet in some instances isolated pieces of the sedimentaries have been embraced in the igneous rock, and so completely fused with them, that the minerals, that otherwise characterize each, are closely mingled over small intervals.

The rocks of the second or metamorphic group, on the other hand, are, in nearly all cases, of a reddish color. They show all stages of metamorphic change—from red sedimentary shale and sandstone to red felsite and syenite The minerals that are invariably found in this rock, when completely crystalline, are quartz, orthoclase, and hornblende. The beds from which these crystalline red rocks were derived are seen interstratified with regularity with the rocks of the other group. But when these red rocks are crystalline or subcrystalline, the alternation is less evident. The alternation in this changed condition is less frequently seen in horizontal layers, but rather appears in sudden verticle replacement. In some places they appear to have had a great thickness, and they constitute, in their changed condition, some of the most interesting features in the geology of the north shore. The red felsite of the Great Palisades containing crystals of adularia, which is underlain by a very characteristic doleryte of the igneous group, and penetrated by numerous dykes from it, can be traced, in varied steps, on the one hand to its original condition, a shale of the Potsdam formation; and in the other direction, through step after step of metamorphic change, to a hard crystalline rock of red color and of a granular texture consisting essentially of orthoclase, quartz and hornblende. It is not always possible to observe a continuity of bedding from one extreme condition to the other. The circumstances of upheaval and metamorphism have generally been unfavorable for that. Some of the links are wanting in nearly every series of observations, but they are such as are supplied at other places—such places also failing to show other links. It may be supposed that it is necessary to make a perfectly connected series of contiguous observations, on a rock, *in situ*, changing from step to step, without interruption of the beds by dip or other cause, in order to establish the series; but such is not the case. When it once becomes evident that certain mineral associations are constant, if a part of these associations are observable, the rest may be relied on. When it is understood that there are two great sources of crystalline rock, the igneous and the metamorphic, and some of their related phenomena are established, such established phenomena are indices to show the origin of other new phenomena. Such new phenomena may again be taken in the same way to point others, and these again others. So at last a whole family of phenomena can be grouped together, although at no place can a connected series of all the phenomena be observed. In that manner, step by step, the lithology of the crystalline copper-bearing rocks can be reduced to two series. When these microscopic phenomena are in concord with and are affirmed by the field geology,as in the case on the north shore of Lake Superior, the true solution of some very interesting questions is found. The rocks of the second series, the result of the crystallization of the

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*From the proceedings of the American Association for the advancement of science, Vol. XXX, Cincinnati Meeting, August, 1881.

Potsdam shales and sandstones, are found to occupy a large area in the extreme eastern portion of Minnesota, northeast of Grand Marais, while those of the first series seem to prevail along the shore, and to cause mountain ranges at some distance from the lake.*

The following brief descriptions are intended to give a general idea of the two groups.

(A) ROCKS OF THE IGNEOUS GROUP.

1. (Survey No. 1.) Gabbro, "Duluth Granite." From Rice's Point, near Duluth; the rock of a low mountain range. Contains labradorite and changed augite, the latter being uralitic; also titantiferous magnetite.

2. (Sur. No. 49.) Behind the M. E. Church, Duluth. Contains augite, plagioclase, and magnetite, with viridite and ferrite.

3. (Sur. No. 53.) East Duluth. Coarsely crystalline. Contains plagioclase, augite, magnetite, and delessite, also some chrysolite and biotite. In some places this rock also shows orthoclase, making it resemble No. 5 of the Survey numbers.

4. (Sur. No. 90.) From the E. point of Sucker Bay. Contains plagioclase, augite, magnetite, chrysolite.

5. (Sur. No. 113.) Labradorite rock, from masses included in gabbro at Splitrock point.

6. (Sur. No 116.) From the point half-way between Split-rock point and Two Harbor Bay. Shows a basaltic structure. Contains plagioclase, augite, magnetite, viridite, opacite, and an occasional grain of biotite.

7. (Sur. No 123) From the bluff east of Castle Danger; a doleryte, containing plagioclase, augite, chrysolite, magnetite, and viridite.

8. (Sur. No. 126.) This is the rock that furnishes the black sand at Black Beach, a few miles W. of Beaver Bay, one-half mile up the creek. It seems to consist of plagioclase (labradorite?) hypersthene and magnetite, making the rock hyperyte. The metalloidal surfaces of the crystals in this rock resemble those of the rock of Encampment Island.

9. (Sur. No. 128.) Section of a large crystal of labradorite, from masses embraced in gabbro at Beaver Bay.

10. (Sur. No. 141.) Doleryte: first rock east of the Great Palisades, (lies below the Palisades?) Has augite, plagioclase, magnetite, viridite (and biotite?).

11. (Sur. No. 160) The rock that protects Little Marais on the east: plagiolase, augite, magnetite, also hematite and ferrite.

12. (Sur No. 199.) The rock of Grand Marais Harbor; plagioclase, pyroxene and magnetite; hematite, ferrite, apatite.

13. (Sur. No. 200) Cupriferous gabbro; from N. W. quarter Sec. 24, T. 61, R. 1. W. (up Fall river); plagioclase, augite (diallage?) magnetite, viridite, ferrite. There are thin sheets of native copper disseminated through the mass of this rock.

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*A series of fifty thin sections with samples of the rocks from which they were prepared, were exhibited, and examined at the table by means of polarized light, on a microscope kindly loaned for the purpose by Mr. W. H. Bulloch of Chicago, Ill. They were numbered successively from one to fifty, the first twenty-one being of the igneous group, and the next twenty-one of the metamorphic. The last eight, from forty-three to fifty, were selected to show a mingling of the minerals of both groups in one rock. The samples of rock were numbered in blue shellac with the field number of the survey. The labels attached to the slides name the most evident and abundant of the minerals seen in each, as they have been identified by the writer.

The rock, as a dyke, cuts a rock like that of the Great Palisades—an amorphous, red, but slightly porphyritic orthoclastic felsite.

14. (Sur. No. 221.) From a short distance east of the Brule′ river; plagioclase, diallage and magnetite; coarsely crystalline.

15. (Sur. No. 229.) Doleryte; Red-rock Bay; runs under the E. Palisades.

16. (Sur. No. 161.) From the hill 520 feet above the lake on N. E. quarter Sec. 25, T. 64, R. 7 E., represents the rocks of the hills about Grand Portage; a doleryte, consisting largely of diallage, plagioclase and magnetite, with chrysolite and a little prehnite.

17. (Sur. No. 275.) From the dyke at the brink of Pigeon river falls; augite, plagioclase, magnetite and chrysolite?

18. (Sur. No. 291.) From the extremity of Pigeon point peninsula; like No. 1; gabbro; plagioclase; diallage, chrysolite, viridite and magnetite.

19. (Sur. No. 297.) Gabbro(?) from the English Rapids, on the international boundary, near Grand Portage; associated with the Animikie Group; augite, plagioclase, magnetite.

20. (Sur. No. 637.) The labradorite rock of Beaver Bay from masses embraced in gabbro.

21. (Sur. No. 664.) Augite, plagioclase, magnetite: from a ridge a little more than two miles north of Horse-shoe Bay.

(b) *Rocks of the Metamorphic Group.*

22. (Sur. No. 1 B.) Brownish-red, hornblende syenite, associated intimately with No. 1. Duluth. Contains orthoclase (changed), quartz, hornblende (often changed), magnetite, apatite and ferrite.

23. (Sur. No. 3.) Brownish or reddish rock. In the Rice Point range of hills; suburbs of Duluth; interception of 5th Av. E. and 7th St.; abruptly separated from No. 1 A by a compact dyke; consists essentially of orthoclase (which makes it sparingly finely porphyritic), quartz and hornblende. It also has apatite, magnetite and ferrite

24. (Sur. No. 7.) Brownish-red rock, fine-grained. Between 2nd and 3rd avenues, Duluth, near the lake. Tabular and imperfect crystals of flesh-red feldspar (orthoclase), viridite (from hornblende), magnetite, apatite, and a small amount of quartz.

25. (Sur. No. 8 A.) Rock inclusion in Survey No. 8; very fine-grained gray rock, showing fine crystals of red feldspar, probably orthoclase, but for the most part this is an amorphous, felsitic mass embracing grains of magnetite and viridite, with other minerals.

26. (Sur. No. 8 B.) Porphyry, Duluth. Has orthoclase, chlorite, magnetite and other minute grains; plainly a rock resulting from the metamorphism of the sedimentary beds.

27. (Sur. No. 8.) Sub crystalline, showing much magnetite and quartz; also undistinguishable grains, some of which are probably viridite, hæmatite and pyrite, in a felsitic paste.

28. (Similar to Sur. No. 8 C.) Finely sub-crystalline, nearly destitute of free quartz, brownish or reddish. Duluth.

29. (Sur. No. 17.) Outwardly and microscopically, a thin-bedded red shale or sandrock; east of the Brewery creek, Duluth, at the lake shore. In thin section

shows a rusty felsitic base with much magnetite or menaccanite, and viridite; the whole clouded with amorphous inclusions.

30. (Sur. No. 33 B) Metamorphic shale. Duluth, at the lake shore; has a felsitic (?) ground-mass, showing a porphyritic orthoclase; magnetite, viridite, hæmatite, apatite, quartz.

31. (Sur. No. 67.) Metamorphic shale, London, near Duluth.

32. (Sur. No. 117.) The reddish vein from Two Harbor rock, Two Harbor Bay. Quartz grains and geodic aggregations, in a reddish orthoclase base.

33. (Sur. No. 124.) Rock of the west bluff, at the entrance to Beaver Bay. Quartz grains with impurities, in a reddish, dimmed base that seems to be orthoclastic, magnetite, apatite.

34. (Sur. No. 127.) Hardened gray shale, from near the mouth of Beaver creek. Quartz grains can be seen in an amorphous, apparently felsitic base.

35. (Sur. No. 129.) Similar to 127, but porphyritic with orthoclase and translucent grains like adularia; a few rods N. E. of the mouth of Beaver creek.

36. (Sur. No. 134.) Quartz, orthoclase, magnetite. The quartz makes up about one-quarter of the whole, the orthoclase perhaps two-thirds, but the magnetite is only in occasional grains. This is from the third island east of Beaver Bay.

37. (Sur. No. 136.) Is from opposite the fifth island east of Beaver Bay. Wholly crystalline red rock, containing quartz, orthoclase and much of a green mineral that is probably changed hornblende. This green mineral is generally fibrous, with spreading, fan-shaped radiations, but not always. Sometimes it shows simply a green felted polarization, always green at +.

38. (Sur. No. 138.) The rock of the Great Palisades; an orthoclastic felsite, porphyritic with adularia, resembling Sur. No. 129.

39. (Sur No. 201.) Orthoclastic felsite, with a few distinct crystals of orthoclase and adularia or sanidin. This is the Palisade rock from the Copper mine up Fall river.

40. (Sur. No. 264.) From the same place as Sur. No. 263, east of Wauswaugoning Bay. Quartzite fragment embraced in gabbro, quartz and hornblende in a cement of felsite.

41. (Sur. No. 265.) From the upper part of Sur. No. 263, where in contact with the metamorphic rock. Results from the inclusion of a fragment of the sedimentary beds in the igneous. Contains quartz, orthoclase and hornblende, with ferrite and graphite.

42. (Sur. No. 668.) The "red granite" of the region northeast of Grand Marais. Consists of orthoclase, quartz and changed hornblende with magnetite.

(c) *Mixed Igneous and Sedimentary Rocks.*

43. (Sur. No. 1 A.) Gabbro. Duluth. Rice Point range, near a contact with No. 1 B. Contains labradorite, uralitic augite, and titaniferous magnetite. Some of the augite is changed toward viridite Orthoclase in occasional grains.

44 and 45. (Sur. No. 5.) At the depot, Duluth; labradorite, augite, quartz, magnetite, orthoclase, apatite. The augite is sometimes viriditic and sometimes uralitic.

46. (Sur. No. 6.) Labradorite, augite, magnetite, viridite (perhaps a result of change from hornblende) and an occasional grain of quartz. This is a dark-green,

heavy, homogeneous rock, coarsely crystalline, near the bay, in front of the Clark House, Duluth. The igneous type predominates.

47. (Sur. No. 46.) Rock showing the contact between the igneous and the metamorphic groups, from Duluth. One side of the section is red, and contains: quartz in perfectly distinct and abundant grains, making up about one-third or one-half of the whole; orthoclase, which is next in amount to the quartz, these two making up most of the section; apatite in small quantity; magnetite; ferrite and hornblende (?), in a few brownish-green or greenish grains which, on rotation at +, change from bluish-green to yellowish-green, and back again.

The other side is darker, and contains: plagioclase, augite grains (altered to uralite) disposed among the plagioclase, and in larger grains, sometimes fibrous and sometimes broken irregularly; magnetite in much greater amount than in the red rock; ferrite in small quantity.

48. (Sur. No. 263.) Contains the minerals both of the igneous and the sedimentary beds. From the E. side of Wauswaugoning Bay. Its position and limited extent show its accidental occurrence, and merely local importance. The igneous minerals are labradorite and magnetite. The sedimentary are quartz, orthoclase and hornblende. Apatite spicules penetrate them all.

49. (Sur. No. 282.) From the porphyritic main axis of the north part of Susie Island, near Pigeon Point. Contains plagioclase, orthoclase, hornblende, magnetite, quartz, pyrite.

50. (Sur. No. 675.) The rock of the top of Brule′ mountain, north of Grand Marais. Orthoclase, quartz, hornblende, plagioclase (?) magnetite, viridite, ferrite, chrysolite, apatite.

OBSERVATIONS.

The orthoclase of the metamorphic rocks is more readily disseminated through the igneous rocks than the triclinic feldspars of the igneous are through the metamorphic.

The magnetite of the igneous, as at Mayhew Lake, where it forms extensive beds of iron ore, may be derived from the exceedingly ferruginous sedimentary rocks. Magnetite seems to be always present in the crystalline metamorphic, and is probably the result of partial deoxidation from the indigenous hematite that gives them their color. Chemical analysis of the red shales would perhaps show the presence of titanium with the iron before metamorphism, and would indicate the correctness of this hypothesis. Wherever titanic iron is found in Minnesota, it is where the two series of rocks are in contact or proximity, so far as observed.

A fine shale becoming heated and slowly passing toward fusion will first show crystals of the easier fusible minerals, *i. e.*, orthoclase before quartz; and if the change stop there the resulting rock would be a non-differentiated (or felsitic) ground mass sprinkled with porphyritic feldspar crystals, all the siliceons parts being embraced in the ground mass. On the other hand, a fused sedimentary rock, passing to solidification, will first show crystals of the least fusible minerals, *i. e.*, quartz before orthoclase, and hence will contain more or less perfect crystals of quartz, cutting the sides of the later formed orthoclase. Hence the same metamorphic rock may show no quartz in one stage of metamorphism, but an abundance of free quartz in another. If the rock at first held grains of free quartz they would still remain in the former case, and would be an evidence of its original sedimentary source, and in the latter they would of course be subject to recrystallization.

The term felsite, as used in this paper, is intended to express a non-differentiated, somewhat metamorphic rock, derived from shale, without any reference to the origin of felsite rocks described in other places.

V.

THE MUSEUM.

Report for 1881, *and List of Additions.*

During the year, 955 entries have been made in the Museum register. While the most of these specimens have been obtained through the agency of the survey, as in former years, yet many have been received by exchange and by donations. Exchanges have been made with Profs. C. U. Shepherd, Geo. F. Kunz, E. S. Dana, P. H. Mill, Jr., S. Calvin and S. G. Williams. The principal donors have been Col. J. B. Clough, superintendent of the construction of the Northern Pacific Railroad, who has sent the Museum valuable mammalian and archæological specimens from Montana; Mr. W. E. Swan, who has preserved drillings from various deep wells in the State and presented them to the Museum; U. D. Watkins, fossils and other specimens from Ohio; C. E. Whelpley, preserved drillings from the Minneapolis deep well, and Prof. C. W. Hall, various rock specimens from New England. Other donors are Regents Sibley, Chute and Gilfillan, W. D. Hurlbut, J. M. Sullivan, C. M. Terry, H. A. Strong, R. F. Laythe, Prof. J. S. Clark, S. F. Heath, John A. Green, S. Deutsch, D. A. Locke, H. S. Peters and Dr. Miller, Asst. Surgeon U. S. A., Little Missouri Cantonment.

The fossils that have been collected from time to time have not been reported until their names were determined, and hence the most of them are still unreported. They are simply registered and labeled sufficiently to serve for identifying their sources. The crystalline rocks embraced in the series described in the survey report have not yet been registered in the Museum. They have the survey numbers only. Of some of them numerous duplicates have been obtained.

ELEPHANT'S TEETH FROM MONTANA.

Among the donations to the Museum by Col. J. B. Clough is a large elephant's tooth which is worthy of special mention. Its companion, a small specimen, was presented by Mr. S. Deutsch. The two were obtained in the same locality but seem not to have belonged to the same individual. Unfortunately the larger specimen has begun to disintegrate by crumbling, and it is doubtful whether it can be preserved.

These teeth were obtained near the Rosebud river in Montana, by the parties constructing the Northern Pacific R. R , but their special stratigraphical relations to the rocks of the region it has not been possible yet to ascertain. It has been stated by Mr. Deutsch simply that they were from a deep cut composed of clay and loose rock. The adhering portions of the matrix consist of a coarse, lime-cemented sand, or conglomerate like some known to exist in the cretaceous and tertiary, and the tooth is probably not of post-tertiary age.

The larger tooth measures 12¾ inches in length and 6½ inches in transverse perpendicular section. Across the grinding surface it measures a little more than 3½ inches. It has, distinctly preserved, 20 transverse plates. There is an appearance, on the anterior extremity, of a thin, imperfect plate, partly eroded, only a double scale of enamel remaining, separated from the body of the tooth by a little cement. This plate with its cement does not occupy the full width nor depth of the tooth, but was especially pitted to receive the first attrition on the tooth and to maintain its form and position, as the tooth advanced. The posterior end of the tooth also has the appearance of having consisted of one or two more plates originally, but they are now lost by the disintegration which has attacked the whole tooth. Thus the plates must have numbered 22 or 23. The plates existing seem to have all suffered some grinding attrition, but only the anterior sixteen are so worn as to show on the crown the double enamel ridges. The posterior ones, which are more and more inclined forward, the farther they are removed from the front, are either in the immature stage of separate denticles which are not yet united on their summits, or are so involved with the cement that they are not yet even worn so as to produce the annular ridge of enamel exhibited by those farther advanced. The bases of these plates, however, with denticles at their summits, are united together into a common complex fold, firmly binding the tooth in one mass. This therefore seems to have been the sixth or last, molar of a mature elephant, or mammoth, and from the lower jaw.

The smaller tooth has lost by disintegration and fracture apparently about four of its plates from its posterior extremity. While it was found in the same locality it was probably not from the same individual. Its crown appears to have been unequally opposed by the tooth of the other jaw, for its plates are not worn off so as to show continuous transverse ridges of enamel, except on the anterior portion, the greater number of plates being simply rounded over, the denticles standing above the surface with their natural curved contour, with no flattened, grinding sarface. From the fact that the denticles are somewhat worn they must have served for mastication. The smooth, flattened, and oppressed appearance of the anterior extremity indicates that the preceding tooth had not yet been shed, but had been thrust by mastication constantly against it. Still it was not wholly protected by its predecessor, but was exposed *on the end*, as well as on the grinding surface to the attrition of mastication, and its most advanced corner is worn off obliquely by that means. It had about fourteen plates and its length was about ten inches. It was probably the fifth upper molar of the extinct mammoth.

The region in which the teeth were found is not drift-covered, but the soil and surface debris is the result of local disintegration of the cretaceous or tertiary beds. It is hence very probable that these teeth are true fossils, of an age prior to the glacial epoch.

SPECIMENS REGISTERED IN THE MUSEUM IN 1881.

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3736	Aug., 1880	C. W. Hall.	Granite	2	Rockport, Mass		C. W. Hall, Rockport Granite
3737	"	"	Granite	2	Quincy Mass		" Quincy Granite
3738	"	"	Petrosilex	4	Marblehead Neck, Mass	Huronian	" Porphyritic
3739	"	"	Diorite	2	" "	"	"
3740	"	"	Diorite	1	" "	"	"
3741	"	"	Petrosilex	2	" "	"	" Finely Crystalline, weathering surface shows effect of pressure on the bedding
3742	"	"	Granite	2	Manchester, Mass	Montalban	C. W. Hall, considerably weathered
3743	"	"	Serpentine	1	Lynn, Mass		"
3744	"	"	Breccia	2	Marblehead Neck, Mass	Shawmeet	" Petrosilicious
3745	"	"	Breccia	6	" "	"	" Water-worn and weath'd
3746	"	"	Dialase	2	Salem Harbor Baker' Slam	Naugus H'd Series	" Showing vein of Elvanite
3747	"	"	Feldspar	1	" "	"	" Pyroxenic
3748	"	"	Beach pebbles of Petrosilex	5	Marblehead Neck, Mass	Huronian	" Showing bedded structure
3749	"	"	Beach pebbles of Petrosilex	10	" "	"	" " Porphyritic
3750	"	"	Beach pebbles of Diorite	4	" "	"	"
3751	"	"	Slag from iron furnace	2	Detroit, Mich		" Form'd in smelt'g sc'p iron
3752	Oct., 1880	"	Haematite	1	Kewanaw, ,Vt	Huronian	C. W. Hall, Micaceous and folded by pressure
3753	"	"	Limestone, Glen's Table Block Marble	1	Glen's Falls, N. Y	Trenton	Presented by J. M. Sullivan
3754	"	"	Sandstone	2	Opp Fond du Lac	Potsdam	Used in const'n of Westminister C'h.
3755	Nov., 1880	Geol. Survey	Sandstone	1	Taylor's Falls	St Croix	C M. Terry, show'g lines of iron stain
3756	"	C. M. Terry	Shell Limestone	2	St. Agustine, Fla	Tertiary	Presented by C. M. Terry
3757	Dec., 1880	Geo. Nat. Hist. Sur.	Galenite, (weight 390 lbs.)	1	Galena, Ill	Galena	Purchased by Regent Chute
3758	Nov., 1880	C. U. Shepard	Meteoric Iron found in 1865	1	Bonanza. N. Mexico		By exchange with Prof. C. U. Shepard
3759	"	"	Meteoric Stone, Jan. 30, 1968	1	Poltusk Vasovia, Poland		" "
3760	"	"	Meteoric Stone, Jan. 9, 1866	1	Knyabinya, Hungary		" "
3761	"	"	Meteoric Stone, Feb. 25, 1847	1	Linn Co. Iowa		" "
3762	"	Alf'd R. C. Selwyn	Meteoric Stone, found in 1872	1	Mitchell Co., Kansas		" "
3763	"	Geol & Nat Hist Sur	Eozoon Canadense	3	Petite Nation, Can	(Lan.	Presented by the Geol. Sur. of Canada
3764	Dec., 1880	"	Cubic Galenite, (slab on carb. zinc)	1	Galena, Ill	Galena	Purchased by Regent Chute
3765	"	"	Cubic Galenite	6	"	"	" "

Specimens Registered in the Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3766	Dec., 1880	Geol & Nat Hist Sur	Sphalerite	1	Galena, Ill	Galena	Purchased by Regent Chute
3767	"	"	Pyrite	4	"	"	" "
3768	"	"	Ores from Galena	3	"	"	" "
3769	"	"	Pyrite, (cylindrical stems)	4	"	"	" "
3770	1880	"	Brick	1	Marshall		Warren Upham, (W. A. Crooker, Maker)
3771	"	"	Brick	1	Jackson		Warren Upham, (Maj. H. F. Bailey)
3772	"	"	Brick	1	Marshall		Same, (James M. Lockey)
3773	"	"	Granite	6	Near W line sec 29, Posen, Y. Med. Co.		"
3774	"	"	Granite	21	1½ m S E from Big Stone Lake		"
3775	"	"	Granite (?)		Redwood Falls		" (Quarried)
3776	"	"	Gneiss	25	2 m S E from Montevideo		"
3777	"	"	Gneiss	21	Granite Falls		" Excavated in Main street)
3778	"	"	Cretaceous Sandstone	20	Sec. 12, Altavista, Lincoln Co.	Cret	"
3779	"	"	Granite	3	N E ¼ sec 32, Echo, Y. Med. Co.		" Nearly all this outc'p is Gneiss
3780	"	"	Hornblendic Schist	3	Sec 17, Omro, Y. Med, Co., (N W outcrop)		"
3781	"	"	Hornblendic Schist	8	" (S E outcrop)		"
3782	"	"	Cemented Drift Gravel	3	S W ¼ sec 31, Nordland, Lyon Co		"
3783	"	"	Pottery Clay	3	N part sec 3, Sigel, Brown Co.	Cret	"
3784	"	"	Protogine Gneiss	3	West side Redwood river,		" Opp. Birum's mill.
3785	"	"	Cretaceous Sandstone (?) weathered)	2	N E ¼ sec 20, Eidsvold, Lyon Co	Cret	" On land of Henry Jacobs,
3786	"	"	" " (fresh)	3	" "	"	"
3787	"	"	Red Quartzyte		N E ¼ sec 25, Selma, Cot. Co.	Potsdam	"
3788	"	"	Potsdam Sandstone, (Quartzyte range)		N E cor. sec 36, Germantown, Cot. Co.	"	" At Mound Creek Falls
3789	"	"	Red Quartzyte		W p't S W ¼ sec 6, Dale, Cot. Co	"	"
3790	"	"	Red "		" "	"	" Containing breccia fragments of Pipestone
3791	"	"	Lignitic Sandstone	4	S E ¼ sec 2, Eidsvold, Lyon Co	Cret	" "Petrified tree."
3792	"	"	Clay containing Cretaceous shells	1	Sec 8, T 111, R 38, Redwood Co		" (Absalom Ames' well)
3793	"	"	Gneiss	1	N E ¼ sec 12, T 111, R 38, "		"

3794	1880	Geol & Nat Hist Sur	Pipestone enclosed in Quartzyte	2	S W ¼ sec 2, Amboy, Cot. Co	Potsdam	"	(Much jointed)
3795	"	"	Red Quartzyte	2	S E ¼ sec 23, Selma, Cot. Co	"	"	
3796	"	"	Red "	2	S W ¼ sec 18, Delton, "	"	"	
3797	"	"	Pipestone in Quartzyte	5	W p't S W ¼ sec 6, Dale, Cot. Co	"	"	Peter Schmidt's quarry
3798	"	"	Potsdam Quartzyte	2	N p't sec 31, Stately, Brown Co	"	"	Falls in E branch of Mound Cr
3799	"	"	Sandstone (Oolitic in structure)	1	N W ¼ sec 7, Eidsvold, Lyon Co	Cret	"	
3800	"	"	Lignitic Cretaceous Sandstone	1	N W ¼ sec 3, Sigel, Brown Co	"	"	Overlying pottery clay (No 3783)
3801	"	"	Gneiss (weathered)	1	N E ¼ sec 12, T 111, R 38, Redwood Co		"	
3802	"	"	Cretaceous Sandstone	2	Sec 7, Westerheim, Lyon Co		"	
3803	"	"	Potsdam Quarztyte	2	N E cor. sec 36, Germantown, Cot. Co		"	At Mound Creek Falls
3804	"	"	Cretaceous Sandstone	2	Sec 12, Altavista, Lincoln Co		"	
3805	"	"	Bones and Petrified Wood	4	Shore of Swan Lake, N W Cor Redwood Co	Drift	"	Pres. by Malcolm McNiven
3806	"	"	Lepidodendron	1	Lake Okabena, Worthington	"	"	Pres. by J. A. Phelps
3807	"	"	Quartzyte	3	Mound, Rock Co		"	J. F. Shoemaker's Quarry
3808	"	"	Cretaceous Sandstone, with leaf impressions	1	N side Cottonwood river, sec 25, North Star		"	Pres. by John F. Burns
3809	"	"	Cretaceons Sandstone, (fossiliferous)	1	" "		"	" "
3810	"	"	Brick	1	Brainerd		"	(Mr. Schwartz, maker)
3811	"	"	Sandstone	27	Hinckley, Pine Co	Potsdam	"	
3812	"	"	Trap	4	Watab, Benton Co		"	Forming S E side of T. N. Newson's shaft
3813	"	"	Syenite	2	" "		"	Talcott, Castle & Co
3814	"	"	Syenite	2	" "		"	land of Jos. Campbell
3815	"	"	Trap		Chengwatana, Pine Co		"	
3816	"	"	Syenite, (very dark)	2	N W ¼ sec 33, St. Cloud		"	
3817	"	"	Syenite	3	N. E. ¼, sec 32, St. Cloud		"	
3818	"	"	Syenite	2	S W ¼ sec 17, Haven, 4 m S E of St. Cloud		"	Robbers & Barthelemy's quarry
3819	"	"	Red Syenite	3	Haven, 2 m S E of St. Cloud		"	Breen & Young's quarry
3820	"	"	Gray Syenite	4	" "		"	
3821	"	"	Gray Syenite	3	Sauk Rapids		"	Collins, Mitchell, and Searle
3822	"	"	Staurolitic Schist	2	3 m s of Pike Rpds in E bnk Miss		"	I. P. Lambert's land
3823	"	"	Syenite	2	Sec. 26, St. Joseph, Stearns Co		"	Fred Schilplin's land
3824	"	"	Syenite	1	2 mi. W. of Cold Spring		"	
3825	"	"	Syenite	1	Cold Spring, Stearns Co		"	
3826	"	"	Vein and Reddish Syenite	1	Sec. 27, Watab, Benton Co		"	T. N. Newson's shaft
3827	"	"	Syenite (coarse grained)	2	Sec. 19, St. Augusta, Stearns Co		"	
3828	"	"	Syenite	1	N W ¼ sec 17, St. Cloud		"	
3829	"	"	Syenite (dark)	1	Sec. 27, Watab, Benton Co		"	Hill 1-6 m E. of Newson's shaft
3830	"	"	Syenite (reddish)	1	Sec. 35, Watab, Benton Co		"	H. D. Gurney's quarry
3831	"	"	Syenite (red)	1	Le Sauk, Stearns Co		"	½ m N. of Sartell's grist-mill
3832	"	"	Granite (coarse)	2	Rockville, Stearns Co		"	only rock at Rockville
3833	"	"	Syenite (dark)	1	Sec 27, Watab, Benton Co		"	N W side of hills near Miss
3834	"	"	Syenite (grey)	1	Sec. 35, Watab, Benton Co		"	H. D. Gurney's quarry
3835	"	"	Syenite (dark)	2	2 m s e of Richmond, Stearns Co		"	
3836	"	"	Syenite (reddish, fine grained)	1	Cold Spring, Stearns Co		"	
3837	"	"	Syenite or Granite	1	East p't sec 18, St. Cloud		"	
3838	"	"	Porphyry	1	Sec. 19, St. Cloud		"	(locality not visited)

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3839	1880	Geol & Nat Hist Sur	Rock somewhat used for railroad masonry.....	2	Quarried near Thompson or Duluth..................	....	" (from Brainerd car-shops).....
3840	"	"	Syenite..	1	Sec. 21, Le Saux, Stearns Co...	....	" at Sartell's grist-mill...........
3841	"	"	Syenite (dark).....................................	1	S W cor sec 28, St Cloud.......	....	" (In road.)........................
3842	"	"	Syenite (porphyritic, reddish).................	1	Sec. 27, Watab, Benton Co.	....	" w side of vein T N Newson's shft
3843	"	"	Agates..	1	Royalton, Morrison Co.........	Drift.	" presented by Harry Young.....
3844	"	"	Vein..	1	Sec. 27, Watab, Benton Co......	....	" T. N. Newsons shaft............
3847	"	"	Kaolin..	1	Mouth of Two Rivers, Mor'n Co	Cret.	" Calvin A. Tuttles well..........
3848	"	"	Garnetiferous Schist.............................	....	2 m. below Pike Rapids.........	....	Warren Upham, W. side of Miss. R...
3849	"	"	Pebbles from Sandstone.........................	....	Knife R. bridge on Snake R.....	Potsdam.	" 6 m N. of Bruns'ck, Kan'c Co.
3850	"	"	Sandstone..	6	Knife R. bridge on Snake R.....	Potsdam.	" ....
3851	"	"	"	8	7 m. E. N. E. of Rush City, ½ m. above mouth of Rock Creek	St. Croix.	" Minn. side of St. Croix River.
3852	"	"	"	2	" "	"	" Wis " " "
3853	"	"	" containing large pebbles........	1	" "	"	" " " "
3854	"	"	Red Shale used for paint....	1	St Croix R bet Snake & Kettle R's	"	" a layer in sands'ne on Wis side
3855	"	"	Fossiliferous Shale..............................	5	30 rds. above Taylor's Falls Bg.	"	" West bank St Croix River.
3856	"	"	" "	5	Taylor's Falls..................	"	" ....
3857	"	"	Trap...	1	" "	....	" near N. C. D. Taylor's shaft..
3858	"	"	"	2	" "	....	" ....
3859	"	"	"	1	" "	....	" at Landing...... ....
3860	"	"	"	1	1 m. S. W. Taylor's Falls......	....	" under the conglomerate.......
3861	"	"	"	1	" " "	....	" over " " ....
3862	"	"	Cuprif. Conglomerate in trap rock............	1	" " "	....	" Dip, 12° W S W bed, 8 ft thick
3863	"	"	Vein-matter..	4	" " "	....	" Taylor's Falls, Mining Co.....
3864	"	"	Ore (Arseno-pyrite?).............................	1	" " "	....	" found in Trap..................
3865	"	"	Native Copper.....................................	1	" " "	....	" Taylor's Falls Mining Co.....
3866	"	"	Ore (Ruby blende?)...............................	1	" " "	....	" bet shafts of N. C. D. Taylor & T. F. Mining Co..................
3867	"	"	Sandstone, fossiliferous........................	2	Franconia ½-¾ m north of Munch's mill, St. Croix......	St. Croix.	W Uph'm, in ravine of Lawr'nce Creek
3868	"	"	" "	1	At Munch's mill, Franconia....	"	" (Mill is built of this)..........
3869	"	"	Shale..	2	" "	"	" ....

3870	1880	Geol & Nat Hist Sur	Sandstone, fossiliferous........................	10	Franconia, Chisago Co..........	St. Croix.	W. Upham..............................
3871	"	"	Calcareous Tufa..............................	4	" 1-5 m. S of Munch's Mill	....	" used for lime, very large dep't.
3872	"	"	Gneiss (weathered).............................	1	N E ¼ Sec 32 Echo Yel Med Co.	....	" ....
3873	"	"	Granite (coarse, reddish, feldspathic)..........	1	" " " "	....	" at S. end of Gneiss............
3874	"	"	Mica Schist (black) in Gneiss....................	1	" " " "	....	" ....
3875	"	"	Gneiss..	1	N E ¼ sec 12; T 111, R 38, Redwood Co	....	" ....
3876	"	"	Mica Schist (dark) in Gneiss.....................	1	N E ¼ sec 12, T 111, R 38, Redwood Co..................	....	" in two or three masses, each 2or 3 feet long....................
3877	"	"	Gneiss..	1	Redwood Falls.	....	Warren Upham, Main Falls..........
3878	"	"	Trap dike...	1	" "	....	" " ....
3879	"	"	Hornblende Schist................................	1	East Granite Falls............	....	" bet bridge and Pillsb'y's El'or.
3880	"	"	" (jointed, traplike)............................	1	" "	....	" at Pillsbury's elevator........
3881	"	"	Red Quartzyte.....................................	1	N W ¼ sec 29, Adrian, Wat. Co.	Potsdam.	" ....
3882	"	"	" "	1	S E ¼ sec 30, Delton Cot. Co. ..	"	" ....
3883	"	"	" "	1	N W ¼ s 28, Storden Cot. Co.....	"	" ....
3884	"	"	Specimens of stone................................	....	R. R. well at Heron Lake.......	"	" the red pieces from 180-220 ft., the yellow lower, 1 ft. thick........
3885	"	"	" "	....	" " "	"	W Uph'm, drilled thro. in 1st 180-220 ft.
3886	"	"	Red Quartzyte.....................................	2	Pipestone City.................	"	" quarried by Chas H Bennett..
3887	"	"	Red Quartzyte (ripple marked).....................	2	" "	"	" " "
3888	"	"	Conglomerate......................................	1	4 m. S. W. from Pipestone City.	"	....
3889	"	"	Red Quartzyte.....................................	2	Dell Rapids, Dak., 18 m. N. of Sioux Falls..................	"	" ....
3890	"	"	" "	2	Sioux Falls, Dak..............	"	" ....
3891	"	"	" "	1	Devils Gulch, Minnehaha Co. Dak. 2½ m. N. E. of Palisades	"	" ....
3892	"	"	Pipestone...	1	Palisades, Minnehaha Co., Dak.	"	" stratum 5 ft. thick, 5 rods S. of dam and 10 feet below...........
3893	"	"	" (mottled variety)...............................	1	" " "	"	W. Upham, " " "
3894	"	"	"	1	" " "	"	" ¼ m. S. W. of mill, 7 ft. thick.
3895	"	"	Sandstone (pink)..................................	2	" " "	"	" half way in location and appearance, between pipestone, and "chalk rock", all being in s. plane.
3896	"	"	" (white)...	4	" " "	"	W Up'm, "chalk rock", 20 rds. E of dam, and in plane with pipestone.
3897	"	"	" (white) a var. holding concretions..............	2	" " "	"	W Up'm, "chalk rock" grad ch to this
3898	"	"	" (pink)..	1	" " "	"	" lower pt of bed of "ch'lk r'ck"
3899	"	"	St. Lawrence Limestone............................	1	Judson, Blue Earth Co.........	Lr. Mg.	" Mrs G W Wolf's qu'y at house
3900	"	"	" " " (arenaceous)................................	1	" "	"	" q ⅛ m S E of hs; lower pt of hs
3901	"	"	" " " "	1	" "	"	" ½ m W of Mrs G W Wolf's hs; lower part of beds.................
3902	"	"	" " " "	1	" "	"	W. Upham, C. G. Swanson's quarry
3903	"	"	Jordan Sandstone..................................	1	Near center of N W ¼ sec 12 Jud.	Jordan.	" brink of unnamed water fall.
3904	"	"	" "	1	Minneopa Falls, Blue Earth Co.	"	" ....
3905	"	"	" "	1	N. W. ¼ sec. 17, South Bend, Blue Earth Co...	"	" ....
3906	"	"	Shakopee Limestone................................	1	South Bend, Blue Earth Co.....	Shakopee.	" David P Davis' quarry.......
3907	"	"	" "	2	L B'nk, Wat. R, N E of G'dn C'y	"	" qy. on S M Folsom's estate..
3908	"	"	" "	1	W. side Maple R., S W ¼, sec. 12; Rapidan B. E. Co.........	"	" Columbus Ballard's quarry.

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3909	1880	Geol & Nat Hist Sur	Sandstone containing lignite-particles..........	1	Sec. 6 Rutland, Martin Co......	Cretaceous.	“ G S Livermore's land, sometimes oolitic, like the Altavista stone which perhaps corresp'ds with this.
3910	“	“	Sandstone..............................	2	“ “ S side Elm Creek...	“	Warren Upham, G S Livermore's land.
3011	“	“	Willow leaf in sandstone (A).................	2	Sec 25, North Star, Brown Co....	“	same, N. bank of Cottonwood River.
3912	“	“	“ “ “ (B)..................	1	“ “ “ “	“	“ “ “ “
3913	“	“	Clay..................................	1	R R well at Wal't Grove, Red Co	“(?)	“ 60- 80 feet.....................
3916	“	“	Iron Pyrites............................	1	P. Crampton's well, S W ¼ sec 8, Eidsvold Lyon Co..........	“	“ ....
3920	“	“	Gypsum................................	1	Sec. 28, Grand View, Lyon Co.	“	“ S. W. Lathe's well.............
3921	“	“	Clay in hollows of Shakopee Limestone.........	1	South Bend, Blue Earth Co.....	“	“ ....
3922	“	“	Clay..................................	1	Red Jacket Mills, Blue Earth Co	“	“ used by A Gapter at Mankato for pottery...............
3923	“	“	Gravelly Clay...........................	1	“ “ “	“	“ thin layer in sand at base of Gapter's clay bank..........
3924	“	“	“Chalk”...............................	1	“ “ “	“	“ Gapter's clay-bank............
3925	“	“	Limestone..............................	1	White Earth Agency.........	Drift.	“ boulders and gravel, common.
3926	“	“	Specimen of the “Three Maidens”.............	1	Pipestone Quarry, Pipestone Co.	“	“ originally one gigantic boulder.
3927	“	“	Calcareous Tufa.........................	....	Camden Mill, Lynd, Lyon Co.	....	“ ....
3928	“	“	Septaria...............................	1	Jackson, Jackson Co...........	Drift.	“ from a cellar, pres. by G. C. Chamberlin...................
3929	“	“	Septaria-like stone.......................	1	Sec. 6 Rutland, Martin Co......	“	“ ....
3930	“	“	Drift gravel, cemented by calc. tufa............	1	Garden City, Blue Earth Co., 20-30 rds E of E T Nort'n's hs	“	“ S E side Wat. River............
3931	“	“	Iron-cemented gravel......................	1	Red Jacket Mills, Blue Earth Co	“	“ above pottery clay (3922)......
3932	“	“	Petrified wood..........................	....	“ “ “	“	“ found by Georgie S. Bingham..
3933	“	“	Wood, S. C. Gale's well.....................	....	Sec. 10, Gales, Redwood Co......	“	“ at 27 feet, below blue till.......
3934	“	“	Hollowed pebbles.........................	....	“ “ “	“	“ presented by S.C. Gale........
3935	“	“	Hollowed pebbles.........................	1	S. W. Minnesota................		
3936	“	“	Efflorescence............................	....	Sec 14, Iona, Murray Co........	“	“ ....
3937	“	“	(Scale)................................	1	Marshall, Lyon Co.............	....	“ from thresher boiler used 3 mo
3938	“	Geo. F. Kunz.	Vertebra...............................	1	Charleston, S. C................	Cretaceous.	By exchange.....................
3939	“	“	Chlorophane............................	1	Hardin Co., Ill.................	....	“ ....

3940	1880	Geo. F. Kunz.	Celestite and Sulphur	1	Mt. Girgenti, Sicily	Cretaceous.	By Exchange	
3941	"	"	Sphalerite and Marcasite	2	Missouri		"	
3942	"	"	Calcite, (Dog tooth Spar)	1	Falls of Ohio, Louisvile, Ky		"	
3943	"	"	Silver on Galena and Sphalerite	1	Silver City, Ark		"	Demby mine
3944	"	"	Natrolite	1	Aussig, Bohemia		"	
3945	"	"	Gold and Silver	1	Silver City, Ark		"	Diamond Joe mine
3946	"	"	Whalebone	1			"	
3947	"	"	Aragoanite. "Sprudelstein"	1	Karlsbad, Bohemia		"	
3948	"	"	Gold and Silver	4	Silver City, Ark		"	
3949	"	"	" " in slate	1	" "		"	Diamond Joe mine
3950	"	"	Aphorite	1	Lime Rock, R. I		"	
3951	"	"	Wavellite, (white variety)	1	Bohemia		"	
3952	"	"	"	1			"	
3953	"	"	Ottrelite	1	Ottrez. Belgim		"	
3954	"	"	Magnetite	1	Port Morris, N. Y		"	
3955	"	"	(?)	2	England		"	
3956	"	"	Monazite	1	Koralfet, Sweden		"	
3957	"	"	Elaeolite—sunstone—	1	Magnet Cove, Ark		"	
3958	"	"	Fascicolite	1	Vermont		"	
3959	"	"	Phyllite	1	Chauston, R. I		"	
3960	"	"	Bituminous Coal	Indf	Mahoning Co., Ohio		"	
3961	"	"	Pseudovermiculite	2	Magnet Cove, Ark		"	
3962	"	"	Ore from Iron mine	2	Monroe, N. Y		"	
3963	"	"	Pyrite and Hematite	1	Rossie, N Y		"	
3964	"	"	Vasite	1	Ytterby, Sweden		"	
3965	"	"	Rosettes of Nigrine	6	Magnet Cove, Ark		"	
3966	"	"	Fluorite	2	Hardin Co., Ill		"	
3967	"	"	Brookite on rock	1	Magnet Cove, Ark		"	
3968	"	"	Hydrolitanite	3	" " "		"	
3969	"	"	Perofskite	Indf	" " "		"	
3970	"	"	Schorlomite	1	" " "		"	
3971	"	"	Nacrite on Calcite	1	Lime rock, R. I		"	
3972	"	"	Bowenite	1	Cumberland, R I		"	
3973	"	"	Gehlenite	1	Austria		"	
3974	"	"	Kjerulfin and Tschernakite	1	Norway		"	
3975	"	"	Ludwigite	1	Westphalia		"	
3976	"	"	Erbenstein	1	Karlsbad, Bohemia		"	
3977	"	"	Hornblende in quartz	1	Cumberland, R. I		"	
3978	"	"	Quartz geode	1	Brazil		"	
3979	"	"	Smoky quartz	1	Minas Geras, Brazil		"	
3980	"	"	Glauconite	2	Marlboro, Monmouth Co., N. Y		"	
3981	"	"	Piece of shark's rib	1	Charleston, S. C		"	
3982	"	"	Conglomerate	1	Pennsylvania		"	oil layer
3983	"	"	Pearl Spar	1	Niagara Falls, N. Y		"	
3984	"	"	Calcite, (hexagonal)	1	St. Anthony's Nose, N. Y		"	
3985	"	"	Calcite (dog-tooth spar) and dolomite	1	Lockport. N. Y		"	
3986	"	"	" "	1	Niagara Falls, N. Y		"	
3987	"	"	Petragotus sp?	1	Buffalo, N. Y		"	
3988	"	"	Calc tufa, replacing sticks	1	New York		"	
3989	"	"	Coral	4	Falls of Ohio, Louisville		"	
3990	"	Geol & Nat Hist Sur	Shakopee limestone	3	St. Peter, Nicollet Co	Shakopee.	Warren Upham,	Jno. Malgrien's quar'y

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
3991	1880	Geol & Nat Hist Sur	Shakopee Limestone, (weathered)	1	St. Peter, Nicollet Co	Shakopee.	Warren Upham, A. J. Lamberton's quarry, worked by Hugh Brogan.
3992	"	"	"	1	Eagle Creek, 1 m E of Shakopee	"	Warren Upham, Thos. Durose's land.
3993	"	"	"	2	Mankato	"	" George Maxfield's quarry, the three foot shaly cement layer
3994	"	"	"	1	"	"	" Geo. Maxfield's best cut stone 4 feet thick, next below the shaly layer
3995	"	"	"	1	"	"	" Geo. Maxfield's quarry, cut stone at 6 feet above shaly layer
3996	"	"	"	1	"	"	" Geo. Maxfield's, 12 or 15 feet above shaly layer; red layer of cut stone 3 feet thick
3997	"	"	"	3	Lime S E ¼ sec 19, Blue Earth Co	"	" Joseph Kunz's quarry
3999	"	"	"	1	Mankato	"	" J. R. Beatty—the quarry on road to Red Jacket mill, said to yield good hydr. cement
4000	"	"	"	3	Lime sec 20, Blue Earth Co	"	" J. R. Beatty
4001	"	"	" (iron-stained)	1	1–5 m s of Sioux City, Merriam Junction, Scott Co	"	" In railroad cut
4002	"	"	"	4	Sec. 18, Decoria, Blue Earth Co	"	" Matt Ryan's quarry
4003	"	"	Jordan sandstone	2	Jordan, Scott Co	Jordan.	" Frank Nicolin's quarry
4004	"	"	"	3	" "	"	" Foss, Wells & Co's. quarry
4005	"	"	Trenton limestone	3	Sec. 27, Eureka, Dak. Co	Trenton.	" Amund Torgerson's quarry
4006	"	"	Boulder containing a green mineral	3	Blooming Grove, Waseca Co	Drift.	"
4007	"	"	Pebbles and Boulders	Indf	Sec. 13, Kiester, Farib. Co	"	" from top of Kiester hills & kames
4008	"	"	Round pebbles from hollows in Shak. limestone	....	Sec 19, Lime, Blue Earth Co		" At J. Kunz' quarry, probably preglacial river gravel
4009	"	"	Boulder (15 ft. in diameter)	1	1½ m. E. of Shakopee	Drift.	"
4010	"	"	Black, fetid mud	1	Freeborn, Freeborn Co	"	" 1 foot thick in well at 95 feet
4011	"	"	Upper Till	1	" "	"	" coal boring, 1880
4012	"	"	Dark, very hard Till	1	Verona Star Mills	"	" Alex Halliday

4013	1880	Geol & Nat Hist Sur	Dark, very hard Till, sandy portion of	1	Verona Star Mills	Drift.	Warren Upham, Alex Haliday
4014	"	"	Yellow Till	1	" "	"	Same "
4015	"	"	Brick, cream-colored	2	Mankota, Minn		" Mankato Brick Co
4016	"	"	Brick, red	1	" "		" " "
4017	"	"	"	1	" "		" F. Polchow & Co
4018	"	"	"	1	" "		" Williams & Grothe
4019	"	"	"	1	Sec 8, McPherson, B. E. Co		" Gekler Bros
4020	"	"	"	1	Sec. 11, Verona, B. E. Co		" Westbrook & Ferguson
4021	"	"	"	1	Albert Lea		" Rusfeldt & Kleven,
4022	"	"	Lignite	3	Little Missour. R. Dak		N. H. Winchell
4023	"	"	Silicified wood	2	" "		Same
4024	"	"	"	1	" "		Presented by Capt. Wolfalk,
4025	"	"	Concretions of (?)	2	" "		N. H. Winchell
4026	"	"	Slags	3	" "		Same { Produced by burning of lignite beds
4027	"	"	Indurated clay, (red)	3	" "		" " " "
4028	"	"	" (banded)	3	" "		" " " "
4029	"	"	Limestone	15	Lanesboro	St Lawrence	"
4075	"	"	"	17	Near Spring Valley	Trenton.	" Weisbach's Dam
4089	"	"	" slab	1	Spring Valley	Galena.	"
4096	"	"	Silicious buhr-stone	1	Bennington, Mower Co	Drift.	"
4099	"	"	Limestone	13	Lime City	Galena.	"
4108	"	"	Lead ore, (on the St. Lawrence Limestone)	3	Dresbach, Minn	St. Croix.	" Winona Co. Mining Co
4109	"	"	Green sand	3	"	"	" " "
4110	"	"	Flag and sandstone, (lingula bearing)	12	"	"	" " "
4111	"	"	Iron septaria	2	"		" " "
4112	"	"	Freestone	1	"	St. Croix.	" " "
4114	"	"	Brick	1	Sec. 34, Manomin		Warren Upham, Peterson & Benson.
4115	"	"	Mineral Paint	1	Redwood Falls.		" Manufactured 1869.
4116	1881	H. A. Strong.	Limestone	1	Decorah, Iowa	Trenton.	{ Pres. by H. A. Strong, Decorah, "Fossil Marble"
4117	"	Edw. S. Dana.	Danburite, Crystal groups	3	Russel, St. Lawrence Co., N. Y.		By exchange with Yale College
4118	"	"	" detached crystals	2	" "		Same
4119	"	"	"Pallas Iron," meteoric	1	Krasuojarsh, Siberia		" Date of discovery, 1876
4120	"	"	Meteoric Iron	1	Augusta Co., Va		" Date of discovery 1858-59
4121	"	"	" stone	1	Sleele-Nowy, Poland		" Date of fall Jan 30, 1868
4122	"	"	" "	1	Weston, Conn		" Date of fall, Dec. 14, 1867
4123	"	"	" iron	1	Sylanieza, Hungary		" Date of discovery, 1844
4124	"	"	" stone	1	Parnallee, India, (Hindostan)		" Date of fall, Feb. 28, 1867
4125	"	C. W. Hall.	" iron, showing Widmanstathian figures	1	Estherville, Emmet Co., Iowa.		Presented: date of fall, May 10, 1879
4126	"	G. H. Dike.	Ammonites sp. (?), part of a cast	1	Foot hills, Black Hills		" by Mr. Dike
4128	May, 1879	By Purchase.	Peckhamite	Sev.	Estherville, Iowa		{ The new mineral found in the Estherville meteorite and named by Dr. J. L. Smith after Prof. S. Peckham. (See Am. J. Aug. 1880)
4129	Oct., 1880	J. S. Clark.	Hematite	1	East River mines, N. S.		Presented by Prof. Clark
4130	"	"	Fossil plants	Sev.	{ Still arton coal mines, Pictou Co. N. S.	Carbonifer's	Same { characteristic plants from the N. S. coal
4131	July, 1880	Geol & Nat Hist Sur	Sandstone	3	Taylor's Falls		C. M. Perry, (south of the "dike")
4132	"	"	Orthoceras, section	1	Shore of Star Lake, O. T. Co.	Drift.	Same
4133	"	"	Blue clay	1	Evansville	"	" (50 feet below surface)

Specimens Registered in Museum in 1881—*Continued.*

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	When.	Whence.					
4134	July, 1880	Geol & Nat Hist Sur	Part of pebble	1	Fergus Falls	Drift.	C.M.Ferry,(from clay of Fergus Falls)
4135	"	"	Clay	1	Spirit Knob, L. Minnetonka	"	"
4136	"	"	Decayed stone and concretions	....	Evansville	"	" (clay banks)
4137	"	"	Fine clay	....	Mouth of Turtle R. Polk Co.	"	A. P. Hendrickson
4138	"	N. C. D. Taylor.	Copper ores, etc	Indf	Taylor's Falls		N. C. D. Taylor
4139	"	Geol & Nat Hist Sur	Clay	1	Bed of Miss., T. 145, N. R. 35 W		O. E. Garrison, beneath the river deposits, on flood plain [95]
4140	"	"	Red Quartzite or Sandstone, (conglomerated)	1	Pokegama Falls	Potsdam.	O. E. Garrison, (Upper strata where the arrow like fall begins), [96]
4141	"	"	" "	1	" "	"	O. E. Garrison, (Upper strata, a little below the apron, 10 feet above water ledge), [97]
4142	"	"	Reddish sandrock	1	" "	"	O. E. Garrison, (Lowest strata visible in the perpendicular walls), [98]
4143	"	"	Coarse sandstone	1	" "	"	O. E Garrison, (Lowest strata visible in the perpendicular walls), [98a]
4144	"	"	Rotted sandstone	1	" "	"	O. E. Garrison, (From apron, flooded in high water(, [99]
4145	"	"	Clay	1	Lower landing, Pokegama Falls		O. E. Garrison, (From gully on bluff). [101]
4146	"	"	Coarse Quartzyte	1	Lower falls Prairie R. sec. 34, T. 56, R. 26	"	O. E. Garrison, (In river bed, covered in high water; cracked in all directions), [102]
4147	"	"	Gray and pinkish quartzyte	1	Lower falls Prairie R., sec. 34, T. 56, R. 26	"	O. E. Garrison, [103], (Near [102], but not flooded
4148	"	"	Red quartzyte	1	Prairie River Falls	"	O. E. Garrison, [104], (Highest point of exposure, and west of the trail from lower landing to lower lake.
4149	"	"	"	1	" "	"	O. E. Garrison, [105], (From a loose scale, but on exposure same as 104.)

4150	July, 1880	Geol & Nat Hist Sur	Red Quartzyte		Prairie R. Falls, sec. 33. T. 56, N. R. 25 W	Potsdam.	O. E. Garrison, [106], (Near the middle of the exposure, near the trail around the upper falls)
4151	"	"	Gray Gneiss	2	Upper Falls of Prairie River		O. E. Garrison, [107], (Near the highest exposure, east of the trail around the falls
4152	"	"	Course Granite	1	" "	Potsdam.	O. E. Garrison, []08], (Highest part of rock, east of the trail around the falls
4153	"	"	"	1	" "	"	O. E Garrison, [109], (From a fissure in the rock near the river, east of the trail around the falls
4154	"	"	"	1	" "	"	O. E. Garrison, [110], (From a fissure near 109)
4155	"	"	Gneiss	1	" "		O. E. Garrison, [111], (Near head of the falls
4156	"	"	Iron Ore	1	Left bank of Prairie River Falls		O. E. Garrison, [112], (From a pit dug in prospecting many years ago
4157	"	"	Iron Ore	1	Right " " "		O. E. Garrison, [113], (Near landing and trail around lower falls
4158	"	"	"	1	Prairie River Falls		O. E. Garrison, [114], (From a pit near 112)
4159	"	"	Sandstone	1	" "		O. E. Garrison, [115] (From a loose fragment in trail around lower falls)
4160	"	"	Clay	1	On Miss. R. below Prairie R		O. E. Garrison, [116], (From a bluff)
4161	April, 1880	J B. Gilfillan.	Section of large (concretion?)	1	Minneapolis	Trenton.	J. B. Gilfillan
4162	1880	P. H. Mell, Jr.	Lircon	3	N. Carolina		P. H. Mell. Jr. By exchange
4163	"	"	Talc. "soapstone"	1	Bartow Co., Ga		" "
4164	"	"	Silicious Tufa	2	Flint River, Ga		" "
4165	"	"	Itacolumite	3	Mitchell Co., N. C		" "
4166	"	"	Clipiasters	3	Thomas Co., Ga		" "
4167	"	"	Blue Corundum	1	Towns Co., Ga		" "
4168	"	"	Garnets in Chlorite	2	Clay Co., Ala		" "
4169	"	"	Impure Agate	1	Flint River, Ga		" "
4170	"	"	Corundum in Zincite	1	Coosa Co., Ala		" "
4171	"	"	Albite	1	Clay Co., N. C		" "
4172	"	"	Brown Corundum and Magnetite	6	Coosa Co., Ala		" "
4173	"	"	Grey Corundum and Tourmaline	3	Towns Co., Ga		" "
4174	"	"	Nodules, sup'sd to be chloride f'm corundum v'n	5	Coosa Co., Ala		" "
4175	"	"	Pink Corundum	8	Towns Co., Ga		" " (from trap dike)
4176	"	"	Tantalite	3	Taleaposa Co., Ala		" " "
4177	"	"	Essonite	6	N. Africa diamond fields		" " "
4178	"	Geol & Nat Hist Sur	Section of Orthocerata	3	Vermont, Blk, R. limestone		S. F Heath
4179	"	"	Artesian-well borings, limestone 80 ft	2	Hastings, Da. Co		Bored by W. E. Swan. I (to 80 ft)
4180	"	"	" " sandrock 15 ft	1	"		By same, II (to 96 ft)
4181	"	"	" " limestone 12 ft	1	"		" III (to 107 ft)
4182	"	"	" " sandrock 8 ft	1	"		" IV (No. 1 at 102 ft), no water
4183	"	"	" " " 10 ft	1	"		" IV (No. 2 at 122 ft), "
4184	"	"	" " " 10 ft	1	"		" IV (No. 3 at 132 ft), "

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4185	1880	Geol & Nat Hist Sur	Artesian-well borings, sandrock, 20 ft	1	Hastings, Da. Co.		Bor'd by W.E Swan IV, (No. 4 at 152 ft) No water
4186	"	"	" " " 20 ft	1	"		By same, IV, (No. 5 at 172 ft)
4187	"	"	" " " 10 ft	1	"		" IV, (No. 6 at 182 ft)
4188	"	"	" " " 10 ft	1	"		" IV, (No. 7 at 192 ft)
4189	"	"	" " " 10 ft	1	"		" IV, (No. 8 at 202 ft)
4190	"	"	" " sandy shale 25 ft	1	"		" V, (to 227 ft)
4191	"	"	" " gray shale 43 ft	1	"		" VI, (to 270 ft)
4192	"	"	" " green shale 20 feet	1	"		" VII, (No. 1 at 290 ft)
4193	"	"	" " " 110 ft	1	"		" VII. (No. 2 at 400 ft)
4194	"	"	" " sandy shale 15 ft	1	"		" VIII, (to 415 ft)
4195	"	"	" " sandrock 20 ft	1	"		" IX, (No. 1 to 435 ft)
4196	"	"	" " " "	1	"		" IX, (No. 2 to 455 ft)
4197	"	"	" " " "	1	"		" 1st flow, IX, (No. 3 to 475 ft)
4198	"	"	" " limestone 20 ft	1	"		" X, (to 495 ft)
4199	"	"	" " blue shale 70 ft	1	"		" XI, (to 565 ft)
4200	"	"	" " green shale 20 ft	1	"		" XII, (to 585 ft)
4201	"	"	" " limestone 5 ft	1	"		" XIII, (to 590 ft)
4202	"	"	" " sandrock 5 ft	1	"		" XIV, 2d flow, (No. 1 to 596 ft)
4203	"	"	" " " 25 ft	1	"		" XIV, (No. 2 to 690 ft)
4204	"	"	" " " 10 ft	1	"		" XIV, (No. 3 to 630 ft)
4205	"	"	" " " 10 ft	1	"		" XIV, (No. 4 to 640 ft)
4206	"	"	" " " 10 ft	1	"		" XIV, (No. 5 to 650 ft)
4207	"	"	" " " 5 ft	1	"		" XIV, (No. 6 to 656 ft)
4208	"	"	" " " 15 ft	1	"		" XIV, (No. 7 to 685 ft)
4209	"	"	" " " 30 ft	1	"		" XIV, (No. 8 to 700 ft)
4210	"	"	" " " 7 ft	1	"		" XIV, (No. 9 to 707 ft)
4211	"	"	" " " 43 ft	1	"		" XIV, (No. 10 to 750 ft)
4212	"	"	" " " 30 ft	1	"		" XIV, (No. 11 to 780 ft)
4213	"	"	" " " 40 ft	1	"		" XIV, (No. 12 to 820 ft)
4214	"	"	" " red sandstone	1	"		" XV, (No. 1 to 835 ft)
4215	"	"	" " "	1	"		" XV, (No. 2 to 860 ft)
4216	"	"	" " red shale	1	"		" XV, (No. 3 to 870 ft)

4217	1880	Geol & Nat Hist Sur	Artesian well drillings, red sandrock	1	Hastings, Da. Co		Bored by W E Swan, XV, (No. 4 to 885 ft)
4218	"	"	" " red shale	1	"		By same, XV, (No. 5 to 925 ft
4219	"	"	" " red sandrock	1	"		" XV, (No. 6 to 950 ft)
4220	"	"	" " "	1	"		" XV, (No. 7 to 1,000 ft)
4221	"	"	" " "	1	"		" XV, (No. 8 to 1,050 ft)
4222	"	"	" " "	1	"		" XV, (No. 9 to 1,060 ft)
4223	"	W. D. Hurlburt.	Crinoid joints	7	Barrens of N. Alabama	(?)	Presented by W. D. Hurlburt, lowest limestone, the rotted layers still show strata
4224	"	"	Limonite	1	Olmsted Co	Upper Trenton (?	Presented by W. D. Hurlburt, Drift, cut on Eyota & Chatfield R. R
4225	"	"	Pentremites	10	Cumberland Mts. E. Tenn.	Carb Sandstone	Presented by W. D. Hurlburt
4226	"	"	"Mountain Limestone," showing crinoids	1	East Tennessee	Sub. Carb.	" "
4227	"	"	" " " massive coral	2	"	"	" "
4228	"	Mr. Reese.	Fossil wood, showing knot	1	Milk R. Valley, Montana		Presented by Mr. Reese
4229	1879	Geol & Nat Hist Sur	Graphite	Indf	Lake Superior		S. F. Peckham
4230	1880	"	Selenite crystals	"			U. D. Watkins
4231	"	"	Spathic Iron	1	Plymouth, Vt		"
4235	"	"	Vegetable impressions in shales	4	Cleveland, Ohio	Buyhaga shales	" coal, No. 1
4236	"	"	Non-plastic clay	1	Bohaes, Tuscarawas Co., Ohio		"
4237	"	"	Cone in cone	1	Cleveland, Ohio	Buyhaga shales	"
4239	"	"	Shales carbonaceous	sevl	" "	"	"
4240	"	"	Slickinsided coal	1	Brewster bank, Akron, Ohio	"	"
4241	1881	John A. Green	"Anamosa stone"	1	Stone City, Iowa	Up. Silurian	John A. Green, Champion quarries
4242	May, 1881	Geol & Nat Hist Sur	Tellinomya levata (or fecunda, H)	24	Dubuque, Iowa	Mag. shales	Exchange with Prof. S. Calvin
4243	April, 1881	"	Copper	1	Stearns Co	Drift	O. E. Garrison, cut from a large mass
4244	May, 1881	Regent R. Chute.	Coquina	1	St. Augustine. Fla	Ter. (?)	Presented by Regent Chute
4245	1877	Geol & Nat Hist Sur	Building stone one foot square	1	Pipestone quarry Pipestone Co.	Potsdam	N. H. Winchell
4246	June, 1881	"	Limestone, believed to be hydraulic	2	Four miles north of Mankato	Shakopee	"
4247	"	"	White Clay, believed to be kaolinic	3	" "	Cret (?)	"
4248	"	"	Limestone, showing light blue color	2	Mankato	Shakopee	" Maxfield's quarry, deep seated beds
4249	"	"	Elephant's tooth	1	Near the Rosebud R. Mon	Cret. (?)	Presented by S. Deutsch, (per Col. J. B. Clough)
4250	July, 1881	"	Artesian well drillings, black soil	1	Lake City		Presented by W. E. Swan, (No. 1) 2 ft.
4251	"	"	" " yellow clay	1	"		By same, (No. 2) 42 ft
4252	"	"	" " sand and gravel	1	"		" (No. 3a) 202 ft
4253	"	"	" " gravel from same	1	"		" (No. 3b) 208 ft
4254	"	"	" " "Hardpan"	1	"		" (No. 4) 207 ft
4255	"	"	" " sand	1	"		" (No. 5) 210 ft
4256	"	"	" " sand	1	"		" (No. 6) 220 ft
4257	"	"	" " sand	1	"		" (No. 7) 225 ft
4258	"	"	" " coarse sand	1	"		" (No. 8) 232 ft
4259	"	"	" " sand	1	"		" (No. 9) 290 ft
4260	"	"	" " sand	1	"		" (No. 10) 360 ft
4261	"	"	" " sand	1	"		" (No. 11) 405 ft
4262	"	"	" " sand	1	"		" (No. 12) 412 ft
4263	"	"	" " sand	1	"		" (No. 13) 422 ft

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4264	July, 1881	Geol & Nat Hist Sur	Artesian-well drillings, sand	1	Lake City		Presented by W E Swan, (No. 14), 440 ft
4265	"	"	" " sand	1	"		By same, (No. 15), 445 ft
4266	"	"	" " sand	1	"		" (No. 16), 460 ft
4267	"	"	" " sand	1	"		" (No. 17), 495 ft
4268	"	"	" " sand	1	"		" (No. 18), 500 ft
4269	"	"	" " red shale	1	"		" (No. 19), 505 ft
4270	"	"	" " " sand washed from	1	"		" (No. 20a), 525 ft
4271	"	"	" " " unwashed	1	"		" (No. 20b), 525 ft
4272	"	"	" " " sand washed from	1	"		" (No. 21a), 570 ft
4273	"	"	" " " unwashed	1	"		" (No. 21b), 570 ft
4274	"	"	" " "	1	"		" (No. 22), 600 ft
4275	"	"	" " "	1	"		" (No. 23a), 640 ft
4276	"	"	" " " sand washed from	1	"		" (No. 23b), 640 ft
4277	"	"	" " "	1	"		" (No. 24a), 680 ft
4278	"	"	" " "	1	"		" (No. 24b), 680 ft
4279	"	"	" " "	1	"		" (No. 25a), 700 ft
4280	"	"	" " " sand washed from	1	"		" (No. 25b), 700 ft
4281	"	"	" " " "	1	"		" (No. 26a), 730 ft
4282	"	"	" " " "	1	"		" (No. 27a), 773 ft
4283	"	"	" " " "	1	"		" (No. 27b), 773 ft
4284	"	"	" " "	1	"		" (28), 805 ft
4285	"	"	" " "	1	"		" (29), 820 ft
4286	"	"	" " "	1	"		" (26b), 730 ft
4287	"	"	" " black loam	1	Austin		" (1), 2 ft thick
4288	"	"	" " yellow clay	1	"		" (2), 12 ft thick
4289	"	"	" " sand and gravel	1	"		" (3), 20 ft thick
4290	"	"	" " blue clay	1	"		" (4), 22 ft thick
4291	"	"	" " gray limestone	1	"		" (5), 44 ft thick
4292	"	"	" " gray shale	1	"		" (6), 16 ft thick
4293	"	"	" " blue limestone	1	"		" (7), 64 ft thick
4294	"	"	" " gray limestone,	1	"		" (8), 80 ft thick
4295	"	"	" " piece of limestone	1	"		" Water rose to within 9 ft of surface, from a crevice, furnishing water at 160 ft

4296	July, 1881	Geol & Nat Hist Sur	Artesian-well drillings, soil	1	Britt, Iowa		Presented by W.E.Swan,(1), 4 ft thick
4297	"	"	" " yellow clay	1	"		By same, (2), 6 ft thick
4298	"	"	" " blue clay	1	"		" (3), 75 "
4299	"	"	" " gravel	1	"		" (4), 25 "
4300	"	"	" " "hard-pan"	1	"		" (5), 14 "
4301	"	"	" " brown limestone	1	"		" (6), 57 "
4302	"	"	" " gray shale	1	"		" (7), 77 "
4303	"	"	" " limestone Mag	1	"		" (8), 298 " in this was water contained in a crevice at 470 ft
4304	"	"	" " brown carb. shale	1	"		" (9), 15 ft thick
4305	"	"	" " light limestone	1	"		" (10), 26 "
4309	"	"	Propidoleptus carinatus, Con	2	Owasco Lake, N. Y	Hamilten	S. G. Williams, by exchange
4310	"	"	Discina lodensis, Vanuxem	2	Cayuga Lake, N. Y	Genesec	" "
4311	"	"	Atrypa reticularis, var. prisca	2	Wingfield, Herk Co., N. Y	Cornif.	" "
4312	"	"	Lycopodites vanuxemi. Dawson	1	Groton, N. Y	Chemung	" " (1 m N E)
4313	"	"	Strophomena rhomboidalis	1	Wingfield, Herk Co., N. Y,	Cornif.	" "
4314	"	"	Pteriuea avicula glabella Con	2	Owasco Lake, N. Y	Hamilton	" "
4315	"	"	Tentaculites fissurella	1	Wingfield, Herke Co., N. Y	Marcellies	" "
4316	June, 1881	"	Sandstone		Sec. 8, Middleville, Wright Co	Cret ?	C. L. Herrick, rises 2 ft above Crow R
4317	"	"	"		Sec. 13, (?) Frankfort, "	"	" both sides Crow R.
4318	"	"	Marble	1	Scranton, Vt.	"	N. H. Winchell
4319	Aug., 1881	"	Hudson river shale	1	Cook's quarry, Minneapolis	Hudson R.	"
4320	July, 1861	H H. Sibley	Fossils	22	Mouth of Cheyenne R., Black Hills, Da		Presented by Gen. H. H. Sibley
4321	"	"	Petrified wood	1	Dakota		" "
4322	June, 1881	Geol & Nat Hist Sur	"Molding sand,"		Middleville, Wright Co.	Drift	C. L. Herrick, bank of Crow river
4323	"	"	Drift, characteristic of Wright Co		Kingstone, Wright Co	"	" banks of Crow R. 25-30 ft
4324	"	"	Sand overlying No. 4316		Sec. 8, Middleville, Wright Co	"	" "
4325	"	"	Rib of Manatus	1	Coosau, S. C		Prof.C.U.Shepard, obtained by exch'ge
4326	July, 1881	Geol. Survey	Tooth of horse	1	"		" "
4327	"	"	Charcharadon giganteus (tooth)	1	"		" "
4328	"	"	Charcharodon angustidens (tooth)	1	"		" "
4329	"	"	Charcharodon megalodon, etc., (teeth)	20			" "
4330	"	"	Phosphatic nodules	4	Coosau and Ashley R's, S. C		" "
4331	"	"	Fluorite (emerald green,) with titanite amphibole, etc		Ottawa Canada		" "
4332	"	"	Calcite, (red)		Grattan, Canada		" "
4333	"	"	Deweylite, with chrysotile	3	Templeton, Can		" "
4334	"	"	Zircon	Indf	Henderson Co. N. C		" "
4335	"	"	Knebilite	2	Cumberland, R. I.		" "
4336	"	"	Danburite	3	Russel, N. Y		" "
4337	"	"	Crocoite	1	Beresof, Russia		" "
4338	"	"	Apatite	2	Templeton, Can.		" "
4339	"	"	Apatite crystals	Indf	" "		" "
4340	"	"	Apatite crystals, (reddish)	4	Gratton, Can		" "
4341	"	"	Apatite	1	"		" "
4342	"	"	Apatite	1	Templeton, Can		" "
4343	"	"	Apatite, granular	1	"		" "
4344	"	"	Amphibolite and augite	2	"		" "
4345	"	"	Augite	1	"		" "

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence					
4346	July, 1881	Geol. Survey	Augite	1	Jefferson Co., N. Y		Prof.C.U. Shepard,obtained by exch'ge
4347	"	"	Pelhamite	1	Pelham		" "
4348	"	"	Tourmaline, (brown,) and augite, (white)	1	Governeur, N. Y		" "
4349	"	"	Lederite and augite, (black)	1	Gratton, Can		" "
4350	"	"	Pagodite	1	Washington, Ga		" "
4351	"	"	Apatite	1	Ural mountains		" "
4352	"	"	Margarodite	1	Trumbull, Conn		" "
4353	"	"	Lederite	1	Grattan, Canada		" "
4354	"	"	Rutile	1	Graves Mt , Ga		" "
4355	"	"	Chrysotile in Deweylite	1	Templeton, Can		" "
4356	"	"	Oligoclase	1	Georgia		" "
4357	"	"	Deweylite	2	Templeton, Can		" "
4358	"	"	Fossil wood	2	Coosau, South Alabama		" "
4359	"	"	Idocrase	2	Templeton, Can		" "
4360	"	"	Tremolite in Dolomite	1	Lee, Mass		" "
4361	"	"	Kaolinite	1	Richmond Co., Ga		" "
4362	"	"	Amphibolite	1	Templeton Can		" "
4363	"	"	Vanuxemite	1	Sparta, N. Y		" "
4364	"	"	Pyrosmalite	1	Nordmark, Wermland		" "
4365	"	"	Augite	1	Ottawa Canada		" "
4366	"	"	Lederite, (Titanite)	2	Grattan, Canada		" "
4367	"	"	Pyrophyllite	5	Graves Mt , Ga		" "
4368	"	"	Cuprite mixed with sulphurets of copper	1	Siberia		" "
4369	"	"	Menilite with Glossecollite	1	Coosan, S. C.		" "
4370	"	"	Lazulite	4	Graves Mt., Ga		" "
4371	"	"	Topaz and margarodite	1	Trumbull, Conn		" "
4372	"	"	Amphibolite and calcite (red and blue)	1	Templeton, Can		" "
4373	"	"	Wilsonite	2	"		" "
4374	"	"	Anorthite, (Indianite) with specky Allanite	1	Pelham, Mass		" "
4375	"	"	Rutile	1	Graves Mt., Ga		" "
4376	"	"	Titanite	1	Arendal, Norway		" "
4377	"	"	Apatite in calcite, (red)	1	Grattan, Can		" "
4378	"	"	Calcite, (red) with apatite and biotite	1	"		" "

4379	July, 1881	Geol. Survey	Orthoclase crystals with albite	1	Huntington, Mass		Prof.C.U.Shepard,obtained by exch'ge
4380	"	"	Asbestoid Bronzite	1	Pelham, Mass		" "
4381	"	"	Tremolite	1	Cherokee Co., N C		" "
4382	"	"	Apatite	2	Grattan, Can		" "
4383	"	"	Phosph	2	Spain		" "
4384	"	"	Augite Chromiferous	1	Wakefield, Conn		" "
4385	"	"	Phosphatic nodules, "land phosphate."	1	Ashley Region, S. C		" "
4386	"	"	Pyrula carica	2	Young's Id., S. C	P'stPliocene	" "
4387	"	"	Oliva litorata	7	"	"	" "
4388	"	"	Natica duplicata	Indf	"	"	" "
4389	"	"	Artemis concentrica	3	"	"	" "
4390	"	"	Arca incongrua	5	"	"	" "
4391	"	"	Lutrasia canaliculata	6	"	"	" "
4392	"	"	Terebra acuta	Indf	"	"	" "
4393	"	"	Mactra suniles	1	"	"	" "
4394	"	"	Sigaretus perspectivus	1	"	"	" "
4395	"	"	Scalaria	1	"	"	" "
4396	Oct., 1881	"	Squared slab of roofing slate	1	Near Knife Falls	Huronian	N. H. Winchell, (12in by 26 in by 2 in)
4397	"	"	Hudson River limestone	2	Clinton Falls	Hud R	" { (taken for building stone tests
4398	"	"	Blue sandsrock, (building stone.)	2	Dresbach	St. Croix	"
4399	"	"	Buff sandrock. (building stone.)	1	Dakota	"	"
4400	"	"	Yellow sandrock, (building stone.)	16	Near Fort Snelling	"	"
4401	Aug, 1878	"	Basaltic columns, (triangular.)	3	Grand Marais		C. W. Hall, { Fr'm the natural break-water, Grand Marias harbor
4402	"	"	" (four-sided.)	4	"		"
4403	"	"	" (five-sided.)	1	"		"
4404	"	"	" (six-sided.)	1	"		"
4405	Oct., 1881	C. W. Hall	Quartzyte	2	Devil's Lake, Wis	Potsdam	C.W.Hall,(from cut on C.& N.W.Ry.)
4406	July, 1881	C. M. Terry	Kaolin	3	Aiken, S. C		C. M. Terry presented
4407	Nov., 1881	C. U. Shepard	Meteoric stone, (fell Oct. 13, 1879.) wt 1.75 grains	1	Soko Banjia, Servia		Prof. Shephard, obtained by exch'ge
4408	"	"	" (fell May 22, 1808,) wt 1.48 "	2	Stannern		" "
4409	"	"	" (fell 1871.) wt 1.4 "	2	Searsport, Me		" "
4410	"	"	" wt 1.35 "	1	Little Piney, Mo		" "
4411	"	"	" wt 2.1 "	1	Milena		" "
4412	"	"	Meteoric Iron wt 14.55 "	1	Disco, Baffins Bay		" "
4413	"	"	" (fragments) wt 2.52 "	Indf	Sarepta		" "
4414	"	"	" wt 0.63 "	1	Union Co., Ga		" "
4415	"	"	" (fell 1875) wt 18.35 "	1	Santa Catarina, Brazil		" "
4416	"	"	" wt 4.55 "	1	Bitburg, Prussia		" "
4417	"	"	" wt 24.97 "	1	Auburn, Ala		" "
4418	"	"	" wt 17.5 "	1	Lexington, S. C		" "
4419	"	"	" wt 8.4 "	1	Durango		" "
4420	"	"	" wt 1.98 "	1	Ivanpah, Cal		" "
4421	"	"	" wt 2.3 "	7	"		" "
4423	Oct, 1881	Geol Survey	Pink Quartzyte	1	Sioux Falls, Dak	Potsdam	N. H. Winchell
4424	May, 1881	"	Sassolite	1			"
4425	"	"	Sandstone with lingulae and galenite	12	Dresbach	St. Croix	" (Dresbach's Mine)
4426	Sept, 1881	"	Pressed brick, red	1	Red Wing		

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.	
	When.	Whence.						
4428	Sept., 1881	Geol. Survey......	Fine-grained, gray granite......................	1	S. E. ¼ Sec. 34, 43, 23, Aitkin Co	....	Warren Upham......................	
4429	"	"	Granite, light-colored.........................	1	Sec. 4, 42, 23, Kanabec Co......	....	"	¼m N of the mouth of Cowan's Cr........
4430	"	"	Dark Mica-schist............................	1	" "	....	"	¼m N of the mouth of Cowan's Cr.........
4431	"	"	White quartzose granite......................	1	Sec. 9, 42, 23, "	....	"	Typical rock at the "Jaws of the Upper Falls," Snake River
4432	"	"	Coarse red granite, (superficially red)..........	1	" "	....	"	"Jaws of the Upper Falls" of Snake R..
4433	"	"	Gneiss......................................	1	" "	....	"	30 rods S of "Upper Falls" of Snake River...... ....
4434	"	"	Homogeneous, fine, gray, granite................	1	" "	....	"	60 rods S of "Upper Falls" of Snake River.... ....
4435	"	"	Red granite, enclosing a micaceous mass.......	1	Sec. 16, T. 42, 23 "	....	"	60 rods above head of Lower Falls........
4436	"	"	Fine, homogeneous, white granite..............	2	Sec. 15 & 16, T 42,23 Kanabec Co	....	"	Upper part of Lower Falls of River, the prevailing rock here
4437	"	"	Mica schist..................................	3	" "	....	"	Cent'l p't Lower Falls
4438	"	"	Hard mica schist, attached to dark gneiss......	1	" "	....	"	" "
4439	"	"	Fragile mica schist............................	1	" "	....	"	" "
4440	"	"	Quartz, vein in mica schist....................	1	" "	....	"	Lower Falls, Snake R
4441	"	"	Redish-gray granite...........................	3	S.E. ¼ Sec. 30, T. 40, 24, "	....	"	At Ann Lake dam....
4442	"	"	" "	2	S.W. ¼ Sec. 29, T. 40, 24, "	....	"	At Roll dam, Ann R
4443	"	"	Dark gneiss, (red feldspar)....................	4	N. W. ¼ Sec. 24, T. 41, 31, Morrison Co....................	....	"	BellePr'ie, MorrisonCo
4444	"	"	Coarse gneiss, (white feldspar).................	9	Sec. 21, T. 41, 29, Morrison Co..	....	"	"Granite City".......

4445	Sept., 1881	Geol. Survey......	Fine, red granite........................	5	S.E. ¼ Sec. 35, T. 41, 29, Morrison Co	....	Warren Upham,	N. end big dam, Hillman brook.......
4446	"	"	Coarse gneiss, (white feldspar and biotite)......	2	" "	....	"	S end big dam, Hillman brook.........
4447	"	"	Gneiss, (white feldspar and biotite)............	2	N. W. ¼ Sec. 18, 40, 29 "	....	"	N end lower Roll dam, Hillman brook.....
4448	"	"	Micaceous granite, (white feldspar and biotite)	2	N. E. ¼ Sec. 9, 40, 30, Pierz, Morrison Co..............	....	"	1 m E of Rich Prairie, E side Skunk R . ..
4449	"	"	Micaceous gneiss, " "	2	" "	....	"	" "
4450	"	"	Dark micaceous granite, (gneissic)...........	6	Sec's 18 and 7, T. 41, 30, Morrison Co..................	....	"	1 m. W. of Platt R....
4451	"	"	Coarse, gray granite, (gneissic)................	4	S. W. ¼ Sec. 17, T. 40, 30, Morrison Co...............	....	"	....
4452	"	"	Fine, gray granite, (homogeneous)............	17	S. E ¼ Sec. 13, T. 40, 31, Morrison Co..................	....	"	¼ m. S. of Fish Lake
4453	"	"	Coarse, red syenite........................	4	N. W. ¼ Sec. 18, T. 39, 30, Morrison Co..............	....	"	Buckman twp.......
4454	"	"	"	1	Sec. 29, T. 38, 27, Mille Lacs Co	....	"	W. br. of Rum R.....
4455	"	"	"	2	" "	....	"	W. br. Rum R ¼ m. N. W. from last......
4456	"	"	"	2	Sec. 19, T. 38, 27, "	....	"	Stony Brook dam, W br. Rum R........
4457	"	"	Fine, red syenite, (dyke-like)..................	1	Sec. 24, T. 38, 28, Benton Co....	....	"	W. br. Rum River....
4458	"	"	Coarse, red syenite, (50 rods W. of last).........	2	" "	....	"	W. br. Rum R., 25 rods W. of Roll dam.....
4459	"	"	Fine, red granulite, (compact)..................	2	N. E. ¼ N. W. ¼ Sec. 20, 38, 28, Benton Co.............	....	"	N. of the trap dyke...
4460	"	"	Fine, dark trap, (from a dyke).................	2	" "	....	"	....
4461	"	"	Coarse, red syenite..........................	2	" "	....	"	S. of the trap dyke....
4462	"	"	Porhyritic, red syenite....	4	S. E. ¼ S. W ¼ Sec. 18, 37, 29 Benton Co..................	....	"	Clement Teller's land
4463	"	"	Coarse, micaceous syenite, (white feldspar)....	2	N. E. ¼ Sec. 35, 37, 31. Benton Co	....	"	Used in Bismarck b'ge
4464	"	"	Fine, light granite...	2	" "	....	"	" "
4465	"	"	Coarse, red syenite.	2	" "	....	"	" "
4466	"	"	Micaceous syenite, (gray)......................	4	Sauk Rapids, Benton Co........	....	"	Collins, Mitchell & Searle..............
4467	"	"	" (showing lumbs of dark)...	1	" "	....	"	" "
4468	"	"	Reddish granite, (Porphyritic with albite?).....	4	1 m. E. Sauk Rapids, Benton Co	....	"	25r'sS Gilmanton road
4469	"	"	Coarse, red syenite..........................	4	N. ½ Sec. 11, " "	....	"	Quarry of Collins, Mitchell & Searle...
4470	"	"	Coarse, reddish-gray syenite....................	4	" " "	....	"	From the deeper parts of quarry of Collins, Mitchell & Searle...
4471	"	"	Coarse, red syenite, (has some mica)...........	2	S.E. ¼ Sec. 11, " "	....	"	Wm. Kout's..........
4472	"	"	" " .,..........	3	N.W. ¼ Sec. 18, " "	....	"	E. D. Learned estate
4473	"	"	Dark, fine, trap-rock; dyke 1 ft wide..........	3	" " "	....	"	Cuts No. 4472, E. D. Learned estate.....
4474	"	"	Fine, mixed, (reddish-gray) syenite............	4	S.W. ¼ Sec. 13, " "	....	"	R. W. Leyerly.......
4475	"	"	Fine, red syneite...............	4	N.E. ¼ Sec. 14, " "	....	"	Joseph Moody........

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4476	Sept., 1881	Geol. Survey	Coarse, red syenite	1	N. E. ¼ Sec 14, Sauk Rapids, Benton Co		Warren Upham, Joseph Moody
4477	"	"	Fine, gray syenite	2	2 m. S. E. of St. Cloud bridge		" Quarry of Breen & Young
4478	"	"	" (hammered face)	1	" "		" "
4479	"	"	Red syenite	6	" "		" "
4480	"	"	Porphyritic, coarse, gray syenite	4	20 rods S. of Sauk Rapids bridge		" W. side of Miss River.
4481	"	"	Gray syenite	4	1 m. S. of St. Cloud bridge		" "
4482	"	"	Gray syenite, (reddish)	4	S. W. ¼ Sec. 20, St. Cloud		" Nicholas Scheuer
4483	"	"	Coarse, red syenite	2	" "		" Matthias Leine
4484	"	"	Gray syenite	4	N. E. ¼ Sec. 28 "		" Jacob Streitz
4485	"	"	Reddish-gray, fine syenite	4	N. W. ¼ Sec. 28, "		" Louis Hohmann
4486	"	"	" "	4	N. E. ¼ Sec 29, "		" Fred Hartman
4487	"	"	Coarse, red syenite	4	" "		" "
4488	"	"	Fine, pink syenite	3	Sec. 7, N E. ¼, Le Sauk, Stearns Co		"
4489	"	"	Coarse, red syenite	1	Melrose, Stearns Co		" Ed Clark's mill is founded on this
4490	"	"	Dark dioryte, (6 feet below surface)	4	W. side Melrose, Stearns Co.		" W. H. Rothaermel's well.
4491	"	"	Coarse, Pink syenite,	1	Sauk Center, Stearns Co		" ¼ m S.E. d'p't, S side Ry
4492	"	"	Fine, pink syenite	1	" "		" "
4493	"	"	Fine, pink syenite, including mass of mica schist	1	" "		" "
4494	"	"	Red syenite	1	" "		" "
4495	"	"	Dark dioryte, (N. W. from last)	2	" "		" "
4496	"	"	Dark dioryte	1	" "		" From a well at Barnum's Block
4497	"	"	Pink syenite ? (containing a green mineral)	1	Sec. 17 & 18, Ashley, Stearns Co		"
4498	"	"	Greenish syenite ?	8	" "		" Contains more of the green mineral
4499	"	"	Green syenite ?	1	" "		" Contains much of the green mineral
4500	"	"	Coarse, feldespathic, white syenite	1	" "		" Contains some of the green mineral

4501	Sept., 1881	Geol. Survey	Gray syenite	9	N. E. ¼ Sec. 15, 131, 33, Todd Co		Warren Upham	
4502	''	''	Gray syenite, showing green veins	2	'' ''		''	
4503	''	''	Gray syenite	4	N. E. ¼ Sec. 28, 134, 32, Cass Co.		''	5 m. N. W. from Motley
4504	''	''	Micaceous syenite	4	'' ''		''	''
4505	''	''	Dark traprock	4	'' ''		''	Cutting the last
4506	''	''	Gray, hard slaty quartzyte	2	1 m. N. of Moose L. Station, Carleton Co.		''	Much jointed into rhombic masses
4507	''	''	Hydro-mica schist	7	¼ m S. S. W. Moose Lake Sta., Carelton Co.		''	
4508	''	''	Traprock in schist	2	¼ m. W. of Moose Lake Station, Carleton Co.		''	
4509	''	''	White quartz in Hidro-mica schist	2	¼ m. S. S. W. Moose Lake Station, Carleton Co.		''	
4510	''	''	Hardened gray quartzyte, semi-crystalline	1	Little Falls, Morrison Co.		''	4 rds N. of E. end ferry
4511	''	''	White quartz in vein 1 ft wide	1	'' ''		''	6 ''
4512	''	''	Fine-grained, staurolitic mica slate	10	'' ''		''	E. shore, at falls dip, 15° N. W.
4513	''	''	Mica slate, (shows sedimentation)	1	'' ''		''	''
4514	''	''	Granetiferous fissile, mica slate	3	'' ''		''	
4515	''	''	Mica schist, (fine)	4	'' ''		''	
4516	''	''	Dioryte, (coarse)	1	'' ''		''	At "the point"
4517	''	''	Gray, fine, semi-crystalline, slaty rock	5	N. E. ¼ Sec. 7, T. 130, 30, Morrison Co.		''	Finely micaceous but not slaty
4518	''	''	'' ''	1	'' ''		''	Finely micaceous, (pyritiferous)
4519	''	''	Fine, mica slate	6	Near the mouth of Little Elk R.		''	Shows sedimentation.
4520	''	''	White quartz, (in slate)	1	'' ''		''	
4521	''	''	Micaceous dark dioryte	3	N. E. ¼ Sec. 13. T. 129, 30, Morrison Co.		''	W. of Little Falls
4522	''	''	'' ''	2	'' ''		''	'' (light)
4523	''	''	'' ''	1	'' ''		''	'' (lighter)
4524	''	''	'' ''	2	'' ''		''	'' (lightest)
4525	''	''	Porphyritic, micaceous, hornblende rock	2	'' ''		''	W. of Little Falls
4526	''	''	Micaceous dioryte, (fine)	1	'' ''		''	Contains a decaying green mineral
4527	''	''	Mica schist, (with staurolite)	5	Pike Rapids, Morrison Co.		''	
4528	''	''	'' ''	2	N. E. ¼ 32, T. 128, 29, Morrison Co.		''	Land of C. Gilpatrick.
4529	''	''	Dark compact, (chrysolite bearing?) rock	4	S. E. ¼ 32, T. 128 29, ''		''	Allen Blanchard
4530	''	''	Staurolitic mica schist, (coarse)	6	Sec's 17 & 18, Bellevue ''		''	E. shore Miss. R., (I. P. Lambert
4531	''	''	Fine, mica slate	6	S. E. ¼ Sec. 4, T. 128, 30, ''		''	At Ledoux bridge
4532	''	''	Dark, compact pyritiferous rock, (Dioryte?)	2	Sec. 34, T. 133, 32, Todd Co.		''	Mouth Fish trap br'k.
4533	''	''	'' '' ''	1	'' ''		''	¼ m. above mouth of Fish trap brook
4534	''	''	Mica schist, (finely garnetiferous?)	1	Sec. 34, T. 133, 32, ''		''	Mouth Fish trap br'k.
4535	Oct., 1881	''	Rotting amydaloidal trap	2	Sec. 22, T. 41, 20, Pine Co.	Cupriferous	''	Northern outcrop
4536	''	''	'' ''	3	'' ''	''	''	Southern outcrop
4537	''	''	Copper strained rock	2	S. part Sec 32, T. 40, 19, Pine Co.	''	''	At E bow of Kettle R.
4538 a	''	''	Coarse spar, (carb lime)	2	'' ''	''	''	''
4538 b	''	''	Laminated pearl spar, (carb lime)	12	'' ''	''	''	''
4539	''	''	Siliceous nodule, (parti colored)	1	N. W. ¼ Sec. 4, T. 39, 19, Pine Co.	''	''	

Specimens Registered in Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4540	Oct., 1881	Geol. Survey	Melaphyr	1	N. W. ½ Sec. 4, T. 39, 19, Pine Co.	Cupriferous	Warren Upham, W. side of Kettle R.
4541	"	"	Fine, trap-rock	1	Sec. 17, T. 39, 19, Pine Co.	"	" S. end of Big Island
4542	"	"	"	2	N. W. ¼ Sec. 29, 39, 19, Pine Co	"	" W. shore St. Croix R.
4543	"	"	Core of diamond drill, (trap)	1	S. W. ¼, N. W. ¼ Sec. 25, 39, 21, Pine Co.	"	" Chengwatona Mining Co.
4544	"	"	From 50 ft. vein, (said to bear copper)	1	" "	"	" "
4545	"	"	Calc spar in trap-rock	4	" "	"	" "
4546	"	"	Greenish trap, with calc spar	3	" "	"	" "
4547	"	"	Green amydagloidal trap, (has Thalite)	2	" "	"	" "
4548	"	"	" " "	2	" "	"	" "
4549	"	"	Trap-rock, with spar crystals	2	" "	"	" "
4550	"	"	Calcite crystals	2	" "	"	" Eugene L. Wilcox
4551	"	"	Red conglomerate, (3d belt)	2	½ m. E of Chengwatona	"	" Strike N. 15°, E. dip 70°, S. 75°, E 30 ft thik
4552	"	"	Pinkish sandstone	2	S. part Sec, 34, T 43, 20, Pine Co	St. Croix.	" Ravine W. of Kettle R.
4553	"	"	Coarse, pinkish sandstone	3	S. part Sec. 15, T 42, 20, '	"	" Brink of Lower Falls, Kettle R.
4554	"	"	Coarse gritstone	1	½ m. S. of mouth Grindstone R.	"	" W. side of Kettle R.
4555	"	"	White sandstone	1	S. E. ½ Sec. 30, 39, 19, (Wis.)	"	" E. of most south'n of "Thousand Islands.'
4556	"	"	Argillaceous, red sandstone	1	" "	"	"
4557	"	"	White sandstone.	2	N. E. ¼ Sec. 36, T. 39, 20, Pine Co	"	" Used for court house found'n, Grantsburg
4558	"	"	Red sandstone, (with pebbles)	4	N. part Sec. 23, T. 42, 23, Kenabec Co.	Potsdam.	" E. bank of Snake R.
4559	"	"	" (with coarse pebbles)	3	" "	"	" " "
4560	"	"	" (with dark and light spots)	1	" "	"	" " "
4561	"	"	Calcareous, concretionary shale, (gray)	4	Two Rivers, Morrison Co.	Cretaceous.	" W. shore Miss. R, 25 rods N. of mouth of main two rivers
4562	"	"	Ferruginous, concretionary shale, (spongy)	1	" "	"	" " "
4563	"	"	" " " (compact)	1	" "	"	" " "

4564	Oct., 1881	Geol. Survey......	Lignitic clay..................................	4	Two Rivers, Morrison Co.......	Cretaceous.	War'n Upham	S. E. side main two rivers, 1-10 m. above mouth..............
4565	"	"	Lignite lumps in lignitic clay....................	1	" "	"	"	" "
4569	"	"	Cone-in-cone.....................................	2	" "	"	"	40 rods S. E. of mouth of main two rivers, on W. shore Miss. R.
4570	"	"	Block of bluish clay.............................	1	4 m. E. of Luverne.............	"	"	From depth of 356 ft. in Rock Co. Farming Co's well.......
4571	"	"	Pebbles of limestone and shale................	10	" "	Drift.	"	From Rock Co. Farming Co's well.......
4572	"	"	Soil, (thought to be saline).......	1	N.W.¼ Sec.29, 159, 48, Kittson Co.	"	"	....
4573	"	"	Coal, (contained in sand 141-157 ft below surface.	1	N. E. ¼ Sec. 29, 146, 46, Norman Co......................	"	"	From Lockhart farm.
4574	"	"	Dark concretionary mass from the soil.........	1	Sec. 26, 41, 31, Morrison Co.....	Drift.......	"	Found in plowing by J W Tanner.......
4575	"	"	Gray till, above the blue till.....................	1	Sec. 8, T. 127, 29, "	"	"	Young Bro's mill, main two rivers....
4576	"	"	Blue till..................................	1	Sec. 8, T. 127, 29, "	"	"	" "
4577	"	"	Gray till..	1	St. Francis bridge, Anoka Co...	"	"	E. bank of Rum River.
4578	"	"	Red till, (underlying No. 4577)..................	1	" " "	"	"	" "
4579	"	"	Red till..	1	Sec. 16, T. 121, 24, Wright Co...	"	"	Well of David Bagley, 4.m. E. Monticello.
4580	"	"	Porphyritic hornblende schist.......	2	Sec. 12, T. 140, 46, Clay Co......	"	"	From a boulder 15 ft x 12 ft. x 5 ft.
4581	"	"	Perforated, water-worn boulder................	1	Sec. 7, 129, 29, Morrison Co......	"	"	2. m. N. W of Little Falls R.J.Lambert's well.... ....
4582	"	"	Perched rock, standing on No. 4450.............	1	Sec. 7, T. 41, 30, "	"	"	Standing on points, (8 ft. in diam.)....
4583	"	"	From a boulder of syenite, (like Watab)........	1	Sec. 23, T. 42, 23, Kenabec Co...	"	"	On Snake River.......
4584	"	"	Pebble of conglomerate.	1	Mout of Snake River..........	"	"	....
4585	"	"	Pebble of red conglomerate......................	1	Sec. 6, T. 38, 19, Pine Co.........	"	"	Contains red shale ..
4586	"	"	Compact mottled limestone......................	1	Sec. 1, Springvale, Isanti Co....	"	"	Found in slabs 10-20 feet long............
4587	"	"	Garnetiferous mica schist.......................	4	Sec. 7, Palmer, Sherburne Co...	"	"	From a bou der 25x30 x20 ft.............
4588	"	"	Banded, red, jasper pebble.......	1	Sec. 28, Sauk Rapids...........	"	"	With other pieces, 1 ft. long... ....
4589	"	"	Pebbles, (crystalline rocks)................	10	N. E. ¼ Sec. 26, T. 39, 24, Kenabec Co.........................	"	"	From Fish Lake dam.
4590	"	"	Beach pebbles " "	45	N. W. shore of Mille Lacs, Crow Wing Co............	"	"	Characteristic of shore
4591	"	"	Hollowed pebble, (rounded)........	1	" " "	"	"	....
4592	"	"	Beach pebbles, (some limestone)...............	40	N. E. side L. Alexander, Mor. Co.	"	"	Characteristic of shore
4593	"	"	Pebbles from top of Hole in the Day's Bluff.....	20	N. W. ¼ Sec. 36, T. 41, 32, "	"	"	1½ m. N. E. Little Falls, no limestone.
4594	"	"	Pebbles, (considerable limestone)............ ...	10	Sec. 5, 127, 29, Mor Co..........	"	"	1½ m. N. Two Rivers..
4597	"	"	Concretionary nodule from the Cretaceous.....	8	Sisseton Agency, Dak..........	"	Thomas M. Young,	1¼ m. E of school
4598	"	"	Coarse granite, with tourmaline.................	1	" "	"	"	On Coteau de prai'e..

Specimens Registered in the Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4599	Oct. 1881	Geol. Survey......	Annular section of concretion in pebble........	1	8 m. W. Sisseton Agency, Dak.	Drift.......	Warren Upham, summit of Coteau de Prairie....................
4600	"	"	Fine, yellow clay, (for brick)...................	3	Sec. 26, T. 127, 34, Todd Co ...	"	" E. shore Big Sauk L. 3 m. N. E. of Sauk Center...........
4601	"	"	Dark clay, (laminated and fine)	2	" "	"	" " " "
4602	"	"	Irony, cylindrical concretions.	2	" "	"	" From Pangburn & Moore,s brick clay..................
4603	"	"	Limy, flat concretions........................	2	" "	"	" " " "
4604	"	"	Fragment of large bone........................	1	" "	"	" 10 feet below surface in Pangburn & Moore,s brick clay.
4605	"	"	Red brick......................................	1	2 m. S. Rush City, Chisago Co.	....	" Near R.R.,Spooner & Hayden.
4606	"	"	"	1	Sec. 8, T. 133, 32, Todd Co.... .	....	" H.B.Morrison, 5 m.W.Motley.
4607	"	"	"	1	S.W ¼ Sec.8 T.133, 35,Todd Co.	....	" Murray&Allen,7 m.S.Wadena
4608	"	"	Cream brick...................................	1	Sec. 35, T. 131, 31, Todd Co....	....	" G G.Howe,1½ m.S.E.Clarissa.
4609	"	"	Well " (cream)............................	1	" "	....	" " " "
4610	"	"	Pink "	1	Sec. 26, T. 127, 34 "	....	" Pangburn & Moore 3 m N. of Sauk Center................
4611	"	"	Red "	1	Sec. 22, St. Cloud, Stearns Co..	....	" Greven & Lommel...........
4612	"	"	Cream "	1	Sec. 26, " " ..	....	" Wm. Kruegel..............
4613	"	"	" "	1	" " " ..	....	" Frederick Kuhne............
4614	"	"	Red "	1	Sec. 12, Otsego, Wright Co.....	....	" Ingersoll Bros..............
4615	"	"	Cream "	1	Sec. 20, Grow, Anoka Co.......	....	" Kelsey Bros.,3 m.N.E.Anoka.
4616	"	"	Well " (cream............................	1	" "	....	" " " "
4617	"	"	Cream "	1	Crookston, Polk Co.............	....	" Norris & McDonald..........
8618	"	"	" "	1	" "	....	" W. A. Nercross............
4619	"	"	Pink "	1	Breckinridge, Wilkin Co........	....	" Jos. Hall, E. bank Red R.....
4621	Aug. 1881	"	Magnesian limestone............................	1	Dresbach..........................	St. Law'nce	N. H. Winchell......................
4628	1880	Exchange	Sassolite, lamelated & vitreous,(original No. 1.)	1	Tuscany.	....	In a bottle............................
4629	"	"	Alunogen,yel'w & conretionary..(" No. 2.)	1	Ariege, France..	....	....
4630	"	" ,.........	Anhydrite, violet, lamellated....(" No. 3.)	1	"	....	....
4631	"	"	Cerargyrite,on ferruginous barite(" No. 4.)	1	Chili..............................	....	With gray copper and haematite.....
4632	"	"	Aragonite prismatic,............(" No. 5.)	1	Saragossa, Spain.......... ...	....	Crystallized with red quartz.........

4633	1880	Exchange	Bismuth, native, lamellated, (" No. 6.)	1	Saxony		With arsenical cobalt and arsenate of cobalt
4634	"	"	Smalttie (" No. 7.)	1	Sweden		Fragment of split crystal
4635	"	"	Apatite, white (" No. 8.)	1	Ariege		Concretionary, also brownish and amorphous
4636	"	"	Gypsum in 2 crystalline sheets, (" No. 9.)	1	Montmartre		Reflecting from an incrustation of iron.
4637	"	"	Calcite quartziferous (" No. 12.)	1	Fontainbleau		Sharply rhombohedral, crystals of Fontainbleau
4638	"	"	Freieslebenite, gray (" No. 15.)	1	Hiendelaencina		Amorphous, on gneiss
4639	"	"	Noumeaite, (hyd. Sil. Nickel) (" No. 17.)	1	Noumea, New Caledona		In a network of concretionary quartz.
4640	"	"	Rhodonite (" No. 18.)	1	Spain		With black sulphate of manganese and quartz
4641	"	"	Sulphur and celestite (" No. 19.)	2	Sicily		Prismatic celestite, (on a bluish marl).
4642	"	"	Bornite, massive (" No. 20.)	1	Chili		Massive, variegated copper
4643	1881	Presented	Gold in quartz	1	Black Hills		Presented by D. A. Locke, (Bengal Tiger Mine.
4644	"	By Exchange	Spodumene	1	Sterling, Mass		
4645	"	"	Damourite, (sterling)	1	"		
4646	"	Presented	Slabs with Lingula Melei and Discina Newberryi	3	Berea, O.	Cuy. Shale.	C. W. Hall
4647	1877	Geol. Survey	Pebbles of red quartzyte in the quartzyte	1	Pipestone quarry	Potsdam	N. H. Winchell
4668	1881	"	Mass of Selenite crystals, (original No. 21.)	1	Lit. Missouri Cantonment	Ter ?	" from Dr. Miller
4676	1878	"	Calcareous geode	1	Dakota Territory	Cretaceous	C. A. Morey
4677	1881	Exchange	Freieslebenite	1	Spain		With barite, drusy quartz and siderite.
4678	"	Geol. Survey	Ripple marked slab of red quartzyte	1	Pipestone quarry	Potsdam	Warren Upham, presented by C. H. Bennett
4679	"	"	Building stone block 1 foot square	1	Stone City, Jones Co., Iowa	Niagara	N. H. Winchell, J. A. Green's quarry.
4680	"	H. S. Peters	Quartz crystals, twinning and overlying	1	Herkimer, Herkimer Co., N. Y.		Presented by H. S. Peters
4681	1880	Presented.	Graphite	1	Heath, Mass		
4682	"	"	Corundum, (Emery)		Plymouth, Ct		
4683	"	"	Granite		"		
4684	1881	Geol. Survey	Drilling from deep well, Minneapolis in glass tube		Minneapolis		Well at Washburn C mill, 205 feet, (C. E. Whelpley)
4685	1880	"	" " " " in a glass tube at Emmettsburg, Iowa		Emmetsburg, Iowa		Well is 869 ft., (pres. by W E. Swan)
4690	1881	J. B. Clough	Elephant's tooth, (15 inches long)	1	Near the Rosebud River, Mon.		Presented by J. B. Clough

Specimens Registered in the Museum in 1881—*Continued.*

Serial Numbers.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
4599	Oct. 1881	Geol. Survey	Annular section of concretion in pebble	1	8 m. W. Sisseton Agency, Dak.	Drift	Warren Upham, summit of Coteau de Prairie
4600	"	"	Fine, yellow clay, (for brick)	3	Sec. 26, T. 127, 34, Todd Co	"	" E. shore Big Sauk L. 3 m. N. E. of Sauk Center
4601	"	"	Dark clay, (laminated and fine)	2	" "	"	" " " "
4602	"	"	Irony, cylindrical concretions.	2	" "	"	" From Pangburn & Moore,s brick clay
4603	"	"	Limy, flat concretions	2	" "	"	" " " "
4604	"	"	Fragment of large bone	1	" "	"	" 10 feet below surface in Pangburn & Moore,s brick clay.
4605	"	"	Red brick	1	2 m. S. Rush City, Chisago Co.		" Near R. R., Spooner & Hayden.
4606	"	"	"	1	Sec. 8, T. 133, 32, Todd Co.		" H. B. Morrison, 5 m. W. Motley.
4607	"	"	"	1	S. W ¼ Sec. 8 T. 133, 35, Todd Co.		" Murray & Allen, 7 m. S. Wadena
4608	"	"	Cream brick	1	Sec. 35, T. 131, 31, Todd Co		" G G. Howe, 1½ m. S. E. Clarissa.
4609	"	"	Well " (cream)	1	" "		" " " "
4610	"	"	Pink "	1	Sec. 26, T. 127, 34 "		" Pangburn & Moore 3 m N. of Sauk Center
4611	"	"	Red "	1	Sec. 22, St. Cloud, Stearns Co.		" Greven & Lommel
4612	"	"	Cream "	1	Sec. 26, " "		" Wm. Kruegel
4613	"	"	" "	1	" " "		" Frederick Kuhne
4614	"	"	Red "	1	Sec. 12, Otsego, Wright Co.		" Ingersoll Bros
4615	"	"	Cream "	1	Sec. 20, Grow, Anoka Co.		" Kelsey Bros., 3 m. N. E. Anoka.
4616	"	"	Well " (cream	1	" "		" " " "
4617	"	"	Cream "	1	Crookston, Polk Co.		" Norris & McDonald
8618	"	"	" "	1	" "		" W. A Norcross
4619	"	"	Pink "	1	Breckinridge, Wilkin Co		" Jos. Hall, E. bank Red R
4621	Aug., 1881	"	Magnesian limestone	1	Dresbach	St. Law'nce	N. H. Winchell
4628	1880	Exchange	Sassolite, lamelated & vitreous, (original No. 1.)	1	Tuscany		In a bottle
4629	"	"	Alunogen, yel'w & conretionary (" No. 2.)	1	Ariege, France		
4630	"	"	Anhydrite, violet, lamellated (" No. 3.)	1	"		
4631	"	"	Cerargyrite, on ferruginous barite (" No. 4.)	1	Chili		With gray copper and haematite
4632	"	"	Aragonite prismatic, (" No. 5.)	1	Saragossa, Spain		Crystallized with red quartz

4633	1880	Exchange	Bismuth, native, lamellated,...(“ No. 6.)	1	Saxony		With arsenical cobalt and arsenate of cobalt
4634	“	“	Smalttie (“ No. 7.)	1	Sweden		Fragment of split crystal
4635	“	“	Apatite, white (“ No. 8.)	1	Ariege		Concretionary, also brownish and amorphous
4636	“	“	Gypsum in 2 crystalline sheets,(“ No. 9.)	1	Montmartre		Reflecting from an incrustation of iron.
4637	“	“	Calcite quartziferous (“ No. 12.)	1	Fontainbleau		Sharply rhombohedral, crystals of Fontainbleau
4638	“	“	Freieslebenite, gray (“ No. 15.)	1	Hiendelaencina		Amorphous, on gneiss
4639	“	“	Noumeaite, (hyd. Sil. Nickel)..(“ No. 17.)	1	Noumea, New Caledona		In a network of concretionary quartz.
4640	“	“	Rhodonite (“ No. 18.)	1	Spain		With black sulphate of manganese and quartz
4641	“	“	Sulphur and celestite (“ No. 19.)	2	Sicily		Prismatic celestite, (on a bluish marl).
4642	“	“	Bornite, massive (“ No. 20.)	1	Chili		Massive, variegated copper
4643	1881	Presented	Gold in quartz	1	Black Hills		Presented by D. A. Locke, (Bengal Tiger Mine
4644	“	By Exchange	Spodumene	1	Sterling, Mass		
4645	“	“	Damourite, (sterling)	1	“		
4646	“	Presented	Slabs with Lingula Melei and Discina Newberryi	3	Berea, O	Cuy. Shale	C. W. Hall
4647	1877	Geol. Survey	Pebbles of red quartzyte in the quartzyte	1	Pipestone quarry	Potsdam	N. H. Winchell
4668	1881	“	Mass of Selenite crystals,......(original No. 21.)	1	Lit. Missouri Cantonment	Ter ?	“ from Dr. Miller
4676	1878	“	Calcareous geode	1	Dakota Territory	Cretaceous	C. A. Morey
4677	1881	Exchange	Freieslebenite	1	Spain		With barite, drusy quartz and siderite.
4678	“	Geol. Survey	Ripple marked slab of red quartzyte	1	Pipestone quarry	Potsdam	Warren Upham, presented by C. H. Bennett
4679	“	“	Building stone block 1 foot square	1	Stone City, Jones Co., Iowa	Niagara	N. H. Winchell, J. A. Green's quarry.
4680	“	H. S. Peters	Quartz crystals, twinning and overlying	1	Herkimer, Herkimer Co., N.Y.		Presented by H. S. Peters
4681	1880	Presented	Graphite	1	Heath, Mass		
4682	“	“	Corundum, (Emery)	....	Plymouth, Ct		
4683	“	“	Granite	....	“		
4684	1881	Geol. Survey	Drilling from deep well, Minneapolis in glass tube	....	Minneapolis		Well at Washburn C mill, 205 feet, (C. E. Whelpley)
4685	1880	“	“ “ “ “ in a glass tube at Emmettsburg, Iowa	....	Emmetsburg, Iowa		Well is 869 ft., (pres. by W E. Swan)
4690	1881	J. B. Clough	Elephant's tooth, (15 inches long)	1	Near the Rosebud River, Mon.		Presented by J. B. Clough

ARCHÆOLOGICAL ADDITIONS TO THE MUSEUM IN 1881.

58. Hair of a native of the New Hebrides. Two braids.

59. Two chalcedony arrow points, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

60. One chalcedony spear point, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

61. Two chert arrow points, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

62. One iron arrow-point, from near Young Men's Butte. Dakota. Presented by D. P. Jones.

63. Small stone hammer, withed. From Michigan. Presented by N. H. Winchell.

64. One Indian stirrup, ornamented with white beads. Presented by Col. J. B. Clough.

65. One stone slab, 18 inches in length, apparently used for rubbing and tanning skins. From Dakōta. Presented by Col. J. B. Clough.

66. One hickory bow and rawhide case, with rawhide quiver containing seven arrows, five of them with iron points. From Miles City, Montana. Presented by Col. J. B. Clough.

67. An Indian weapon—a quartz pebble surrounded by a rawhide withe which is extended into a handle about three feet long, terminating with a loop for the wrist, and stiffened by a flexible stick. From Miles City, Montana. Presented by Col. J. B. Clough.

68. Small. perfect arrow-point of quartzose, oolitic, or concretionary chert. Found on the University campus by Mr. Fisher, and by him presented to the University Museum.

69. Stone ax, withed, of dark dioryte, found near Albert Lea. Presented by Rev. L. J. Hange.

70. Pangue knife, from the Ogove river, Africa, said to be made of "native iron," enclosed in a snake-skin sheath. Presented by Rev. G. C. Campbell.

71. Loom and three yards of cloth, made from bast fiber, by the *Ivilli*, of the Ogove river, Africa. Presented by Thos. Sinclair, trader on the Ogove river, through Rev. G. C. Campbell.

72. Native dress, worn by the *Ivilli*, and others up the Ogove river, Africa. Presented by Thos. Sinclair, trader, through Rev. G. C. Campbell.

73. Prehistoric Maize, from the old cemetery near Madisonville, Hamilton county, Ohio. Presented by N. H. Winchell.

VI.

GEOLOGICAL NOTES ON MINNESOTA.

BY MR. J. H. KLOOS.

[Translated by N. H. Winchell.]

[NOTE.—These notes were made by Mr. Kloos when serving as Land Agent of the St. Paul & Pacific R. R. and were published in the *Zeitschrift d. Deutschen Geologischen Gesellschaft*, p. 417. They furnish the basis for the subsequent investigations of Streng and Kloos on the crystalline rocks of Minnesota, and contain original observations on the stratigraphical relations of the formations, which differ from those of his predecessors, particularly on the trap and sandstone at Taylor's Falls. They furnish an important historical link between the surveys of Owen, Whittlesey and Eames, and the beginning of the present survey.]

Since the publication of the geological survey carried on under the direction of the American geologist, David Dale Owen, little that is noteworthy has appeared on the geology of Minnesota.

Owen with his assistants, Norwood, Shumard, Whittlesey and eight others, explored the States of Wisconsin, Iowa and Minnesota from 1847 to 1850. In his report to the government of the United States he gives a careful description of the country in respect to its geography and geology, its fauna and flora, as well as its agricultural resources. The 638 pages of his heavy quarto volume contain a vast amount of valuable and exact observations, especially upon the northern part of the district examined, in which even yet exploration is attended usually with great difficulties. A fault of the work is its petty simplicity. The detailed descriptions of many river-valleys, in respect to topography and climatology, render difficult the attainment of a general view of the geology. The description of the crystalline rocks of Minnesota, which in many respects possess a high importance, is faulty. Also the palæontological subjects are not thoroughly treated, and the illustrations of new species published by Owen possess little merit.[*]

In the year 1866[†] appeared a little pamphlet on Minnesota by Charles Whittlesey, formerly an assistant of Owen. It is confined almost en-

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[*] Report of a Geological Survey of Wisconsin, Iowa and Minnesota, by authority of Congress, by David Dale Owen, Philadelphia, 1852.

[†] A report of explorations in the mineral regions of Minnesota during the years of 1849, 1859 and 1864, Cleveland, 1866.

tirely to the shores of Lake Superior, and describes the conditions and appearance *in situ* of copper and other metals.

The examinations by the State Geologist, Henry H. Eames, pertain exclusively to those parts of Minnesota in which copper, iron and small quantities of gold are found. In his report for 1866 he confines himself to the description of the occurrence of the useful metals and their ores.[*]

An important paper on the geognosy of southwestern Minnesota was published by Prof. James Hall in the year 1866. His design was to examine the outcrop of coal on the Cottonwood river, one of the important tributaries of the St. Peter. or Minnesota river. Owen with his assistants had been only to the mouth of the Cottonwood. Hall penetrated as far as the celebrated locality where the Indians obtained the "Pipestone" for their pipes.[†] He shows that the coal outcropping there belongs to a younger formation—viz.: the Cretaceous—and assumes the former extension of the Cretaceous as well as the older Mesozoic strata, over that part of Minnesota. At the same time he offers some valuable observations upon the crystalline and metamorphic rocks which appear along the Minnesota river above the mouth of the Cottonwood.[‡]

In the following I have sought to gather together in a comprehensive survey my various notes on different parts of Minnesota; and where it has been necessary to a comprehension of the description, and I was not able personally to make examinations, I have filled them out from earlier observations of others. By means of the map I have aimed rather to aid the reader than to present an exhibition of the geological conditions. The points of observation are in the river valleys, separated by wide tracts covered by drift, and we are not at this time in condition to announce with any certainity the boundaries of the formations. I have gathered much material which is designed for a more careful investigation at some later time, and if time and opportunity are afforded me I aim to treat the separate subjects more thoroughly, which now can only be mentioned briefly.

The State of Minnesota in the geographical center of the continent

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[*] Report of the State Geologist, Henry H. Eames, on the metalliferous region bordering on Lake Superior. St. Paul, 1866.

[†] Mr. Kloos has fallen into an error in respect to both Owen and Hall. Owen's assistant, Shumard, ascended the Minnesota valley as far as the mouth of the Redwood river, instead of the mouth of the Cottonwood; while Hall only went as far west as Lake Shetek, instead of to the Pipestone quarry. (N. H. W.)

[‡] Notes upon the Geology of some portions of Minnesota, from St. Paul to the western part of the State. By James Hall, Trans. Am. Phil. Soc. vol. XIII, p. 329.

of North America, lies between 43½ and 49 degrees of north latitude, and between 89½ and 97 degrees of west longitude. This member of the American Union is bounded on the south by Iowa, on the east by Wisconsin, north by the Winnipeg district of British America, and westerly by the territory of Dakota. The area of the state embraces 84,000 English square miles.* A wide wedge, jutting toward the east, extends between Lake Superior and the Rainy lake river which with a succession of small fresh-water lakes forms the boundary line along British America. Therefore Minnesota has a coast line of 160 miles, and a position extremely favorable for trade with the eastern States.

To the geographer, therefore, Minnesota possesses a great intrest, inasmuch as within its borders are found the spring-sources of the great rivers of the American continent. It lies to the north, in the least accessible portion of the United States. Upon the accompanying map of Minnesota can be seen two small lakes, distant but a few miles from each other, known as Itasca and Elbow lakes. In lake Itasca the Mississippi river has its source, and in Elbow lake the Red river of the North. The former flows, as is known, in a southerly direction to the Gulf of Mexico; the other turns with a sharp angle toward the north, unites in the great lake Winnipeg with the waters of the Saskatchewan coming from the Rocky Mountains, and empties with them through the Nelson river into Hudson's Bay. Lastly, the St. Louis and the Rainy lake rivers form the beginning of the extensive fresh-water system which comprises the chain of great lakes, and empties its waters in the Atlantic through the St. Lawrence.†

In Minnesota the banks of the Mississippi and its tributaries, together with the rocky shores of lake Superior, with its many short water courses, and the small lakes in the extreme northern part of the state, afford the only information concerning the age and composition of the earth's crust. As soon as one leaves the river valleys, he finds the older formations covered with heavy rolling hills of sand or clay without organic remains. These later deposits, which form a covering unbroken, except by the river valleys, are a part of the "Drift Formation," of North America. Over an extensive part of this territory it is spread out over the oldest crystalline rocks and on the sedimentary formations, and it extends south to the fortieth degree of north latitude. Even of the drift, in many parts of the state, can an idea of the composition and nature be ascertained only along the separate water-courses, because for days together one can travel without getting sight of a rock or of a hill. Either the grassy, boundless, prairies stretch out in all directions so that the eye cannot discern any tree or shrub, or vast forests, with successive meadows and lakes, cover the country. In the northern part of the state are many impenetrable cedar swamps, and through there it is only possible to pass in winter, when the swamps are frozen.

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*Wherever in this work miles are mentioned, the English Statute miles must be understood, of which 4.61 make a geographic mile.

†Mr. Kloss here loosely refers to the northern waters of the state. In reality the Rainy Lake river does not flow east into lake Superior, but westward into lake Winnipeg. [N. H. W.]

The sand and clay deposits of the drift formation are so thick that the smaller water-falls, the brooks and the rivers which have little descent, afford no additions to the outcropping rock. In southern Minnesota are cuts along the railroads from fifty to a hundred feet deep in which the bluffs show nothing but sand, loam and clay, without any organic remains. The drift forms sometimes a hilly, heavy deposit or extensive terrain, and sometimes a smooth horizontal surface as level as the sea. The depressions and valleys between the hills are generally filled with water, and thus are formed a numberless multitude of smaller and larger lakes. Their shores generally descend gradually, and show in the water-worn masses which gather there, the most varied kinds of crystalline rocks and metamorphic schists. Many swampy spots, both in the forest and on the prairie, are dried up lakes. By further draining these make excellent pasture grounds. The low grounds filled with water in the surface of the drift, are the remains of a single extensive fresh-water lake. In many places can be seen the remains of this old lake deposit. They consist of clay and loam with the same fresh-water mussel and snail shells as live at the present time in lakes and rivers. The southern shore of this lake lies probably not far from the Iowa boundary, where the highest ridges of the plateau are found. At Rochester and Mankato, points south of the Minnesota river, have been found trunks and branches of various kinds of trees, especially oak and cedar, in hills consisting of clay, twenty to fifty feet under the surface, and nine hundred and forty feet above the ocean level. These are all evident proofs that these ridges have once been the swampy shores of an ancient fresh-water basin.

The plains of Minnesota have a hight from 800 to 1,200 feet above the sea-level. The hill-ranges which run in various directions and form the water divides between the rivers and river-systems, reach in some places the hight of 1600 and 1700 feet. These are at the same time also the highest land of the country, and actual mountain ranges of rock do not exist.[*] The passage from the low lands to the water sheds is for the most part imperceptible, and the undulations of the plains, with the exception of the shores of the great rivers, take place altogether gradually. The highest water-shed lies in the northern part of the state, and separates the waters which flow south through the Mississippi valley, from those which have a northerly direction toward Hudson's bay. It is composed, through its whole extent, of drift; also theother divides, and greater elevations of the surface, consist of sand, loam and clay, and it is in the lower grounds and river valleys that one must seek for the older layers of the earth's crust. The shores of the Mississippi, with the range of bluffs lying nearest, consist of rocks which belong to the oldest portions of the Silurian formation. They are sandstones and dolomitic limestones which correspond to the Potsdam and Calciferous Sandstone, as well as the Trenton period, in the state of New York and in Canada. The layers are in all places nearly horizontal; but where the river has excavated the sandstone, and undermined the limestone beds, the latter are thrown down, and in many places over large areas, have apparently suffered an extensive denudation. The formations mentioned are in outcrop from the mouth of the Wisconsin river to the Falls of St. Anthony, over an extent of 210 miles. At the Wisconsin river the higher layers of the Silurian disappear, and there remain only the equivalents of the Potsdam and Calciferous sandrock, from there to St. Paul. The beds have at first a gentle southerly dip, which they maintain to Mountain Island, in the neighborhood of the city of Winona. Here is the highest part of a saddle-shaped elevation, and from there the layers have a dip, though almost imperceptible, toward the north. The elevation and depression in the hight of the separate layers make it possible to establish these conditions most clearly, as has been set forth in several profiles by Owen in an admirable manner. I had the opportunity to examine somewhat carefully the layers in the heighborhood of this saddle. The first line of bluffs rises precipitously to the hight of five or six hundred feet above the floodplain, and shows the outcroping of beds which after considerable interruption have their continuance on the opposite shore. The lowest is a sandrock, and over it are beds of dolomite. The former, which occupies the greater part of the rock-bluff, exhibits a different texture in different places. Some beds are coarse-grained, and approach a conglomerate, and others are very fine-grained. It is in general loose and crumbling with lime-cement. The dolomite, which here may reach a thickness of ninety feet, is of a light color, vesicular-crystalline, and resembles the German *Zechstein-dolomit*. It incloses many calc-spar and flinty concretions, which often attain a considerable size. I could discover no distinct fossils Only in one place did I find a fragment of a coiled cephalopod, which must have been of considerable size. Afterwards I found the same sandstone on the St. Croix river where some of the layers are very rich in bivalves, and I shall mention later their occurrence in describing the same rock again in the neighborhood of Taylor's Falls. The sandstone Owen has named *Lower Silurian sandstone of the upper Mississippi*, and the dolomite he distinguishes as the *Lower Magnesian limestone*. The former answers to the *Potsdam Sandstone*, and the latter to the *Calciferous Sandstone*, of New York. The characteristic fossils are trilobites, which for the most part belong to the genus *Dikelocephalus*, also *Lingula* and *Orbicula*. In Minnesota it is difficult to find any large fragments of trilobites in the crumbling sandstone. Relying on observations made in Wisconsin, Owen distinguishes in this sandstone six trilobite-beds, which are separated from each other by other beds from ten to a hundred and fifty feet thick. In the magnesian limestone have been found up to this time only inconsiderable, and hardly recognizable, remains of fossils. They are a small *Lingula*, casts of the interior of shells which are related to *Euomphalus* and *Ophileta*, also fragments of trilobites like those in the sandstone. The geological horizon, therefore, of the lower dolomite must be determined at present from its position between the Potsdam Sandstone and layers of the Trenton formation.

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[*] According to published elevations, the hight of lake Superior at its low stage is taken at 600 feet. The latest measurements give an average hight of 606 feet) The Water-level varies in different years, and changes even with the seasons.

Before reaching the mouth of the St. Croix river above which both banks of the Mississippi belong to Minnesota, the lower sandstone disappears, and the shores, which have a hight of 200 or 300 feet, consis entirely of dolomite, which exhibits most remarkable water-worn forms, and presents many changes in its outer contour. The bluffs frequently pass back from the water, and the banks become lower. At Red rock, six miles below St. Paul, the hills are half a mile back from the river, while the shores rise but a few feet above the water level, and form a plain which is fertile but exposed to frequent inundations. Small exposures of the dolomite are still to be seen. The bluffs consist almost entirely of the next higher layers, the equivalents of the Trenton formation. At St. Paul the same rocks outcrop by the river, and form a rugged rock bluff from 90 to 100 feet high. From here the Trenton group continues, till, above the falls of St. Anthony, all the layers disappear together under a heavy covering of drift.

At St. Paul the bluffs have a thickness of 65 feet of sandstone, covered by 15 to 25 feet of heavy limestone layers, a repetition, therefore, to a certain extent of the bluffs below. Yet the sandstone hardly deserves this name, in that a cementing material is entirely wanting, and the rock can be dug into as easily as a sand bank. Indeed it is nothing but a vast bed of quartz grains that hardly hang together, in some places, of unusual clearness and transparency. For this reason it has been recommended by Shumard, one of Owen's assistants, for the manufacture of glass. The shining white walls of this sand rise perpendicularly from the water, and reach at Fort Snelling, an old fortification against the Indians, at the mouth of the St. Peter river, its greatest height. From here to St. Anthony the height, as well as the thickness, of the sandstone gradually diminishes. I have never yet succeeded in finding any fossils in this sand, and Owen regards it as entirely destitute of fossil remains. As it everywhere appears in close connection with the overlying limestone beds, which contain a great number of fossils characteristic of the Trenton of New York and the Llandeilo Flags of England, it must for that reason be placed with them in the same group, and is regarded by American geologists as the western equivalent of the Chazy limestone.

It seems at first a remarkable circumstance that so old a sandstone, covered by limestone beds, should possess so little firmness, but on examining carefully the stratification, a shale bed is discovered between the limestone and the sandrock, by which a supply of limy cement must be entirely cut off. Indeed in the upper part of the sandstone are shaly layers, and they attain, under the limestone, a thickness of one and a half to two feet. The shale has a dull blue color, effervesces with acids, on being dried falls away in long shaly fragments, and is converted to a thick paste when exposed to the influence of water and air.

Concerning the stratification of the Trenton, as it is displayed on the upper Mississippi, I shall speak in a later work.[*] The cities of St. Paul, Minneapolis and St. Anthony are built upon the same rock-beds, and in St. Paul especially are found numerous outcrops. The limestones are clayey or dolomitic. The middle portion, which is the greatest, furnishes a very good building material, of which the stone structures of the cities mentioned are built. The best known fossils are:

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[*] The layers of the Trenton have had formerly a much greater extent. In southeastern Minnesota are many isolated patches of limestone and of the St. Peter sandstone yet to be brought to light and described. The fine sand which has so great an extent in the banks of the St. Peter river is derived from the weathered and scattered debris of sandrock.

Orthis tricenaria. Conrad.
Orthis testudinaria. Dalm.
Leptaena sericea. Sow.
A smooth *Pentamerus* and a *Strophomena.*
Murchisonia bicincta.
Bellerophon bilobatus. Sow.

All characteristic shells of the Trenton, and partly also of the Llandeilo Flags of England.

In the higher layers are added corals and brachiopods as well as a trilobite, which are not seen in the lower layers. They are for the most part the following:

Rhynchonella recurvirostra. Hall.
Rhynchonella increbescens. Hall.
Petraia corniculum. Hall.
Stenopora fibrosa. Goldf.
Calymene senaria. (*Blumenbachii.*)
Ptilodictya sp.—

fossils which altogether have been assigned to the Trenton by Logan in Canada.

Six miles above St. Paul the Minnesota or St. Peter's river empties into the Mississippi, having its source in a lake on the boundary line of Dakota. In its banks the lower beds of the Silurian again outcrop. Still its banks remain much lower than those of the Mississippi, and the lower sandstone nowhere reaches a greater thickness than 35 feet above the water.*

Between Minneapolis and St. Anthony, which lie opposite each other, the Mississippi forms at the present time a water-fall which, in a manner similar to Niagara, only at a greater rate, is kept in constant recession. The white sandstone, or rather the sand bank, is exposed unceasingly to the influence of the falling water. It is washed out, and the overlying limestone beds are broken off in great sheets which fall down. This process can be observed everywhere in the neighborhood of the falls In the midst of the river-channel lie the limestone masses scattered here and there in wild confusion. The falls are now but twenty feet high, yet must have had formerly, when the water plunged from the limestone beds, further down the river, a much greater height. Plans have been sought for to keep the falls in the same place by means of dams, canals and locks, since both St. Anthony and Minneapolis are manufacturing cities, and the timber from the northern part of the State is here sawed in a large number of mills.

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*The "Lower Sandstone" here referred to is the Jordan sandstone, and is not the "Lower Sandstone" seen in the Mississippi bluffs. [N. H W.]

Every little stream that enters the Mississippi over its high bluffs exhibits in a small way the same phenomena. Hence arise a number of smaller very picturesque water-falls, which are met with in the neighborhood of both the cities mentioned, among which Minnehaha (Laughing-water) is best known.

The Trenton limestone is the youngest member of the Silurian formation that I have as yet been able to find in the banks of the Mississippi.* In southern Minnesota it seems also that the equivalents of the Hudson river and Clinton formations are found. During the writing of this sketch I have seen in an American teacher's monthly journal a little treatise on the geology of southern Minnesota, in which the author mentions in the banks of Root river, a tributary of the Mississippi, a hundred and forty feet of beds of shale and shaly layers overlying the Trenton limestone, and covered by still other beds of sandstone with a thickness of a hundred and fifty feet.† Still I have not been able to learn anything in detail concerning these layers; and inasmuch as no fossils from these beds were mentioned their age still remains questionable, although it is not unlikely that the younger members of the Silurian pass from northern Iowa to this side of the Minnesota boundary. I have exhibited the boundaries of the Upper Silurian and Devonian in southeastern Minnesota on the accompanying plate, according to the representation of Mr. Hurlbut.

Above St. Anthony the older formations are covered by sand and drift for a distance of sixty miles, and the banks of the Mississippi show no outcrops. A few miles below the city of St. Cloud the area of the crystalline rocks begins. The stratigraphical relations of the sedimentary formations in respect to these outcrops of granitic rocks unfortunately cannot be ascertained. The most southerly point at which I found the granitic rock was on the Sauk river, one of the important tributaries of the Mississippi river in this region. Also between these rivers low outcrops of granite rock suddenly appear in the midst of the forest. In the banks of the Mississippi itself no outcrops of granite are known so far south. The strike of the crystalline rock seems, for that reason, to run in a north northeasterly direction. It forms low hills, and flat, or somewhat rounded, knolls, which rise suddenly above the swampy plains. The Mississippi continues twenty miles in this way—toward the north then it enters on a belt of metamorphic schists of about the same width, of which I only had information of a mica-schist containing a great number of beautiful staurolite crystals.

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*The Hudson River beds can be seen at St. Paul, with a thickness of about 100 feet. [N. H. W.]

†W. D. Hurlbut, in the Minnesota Teacher, February, 1871.

The crystalline rocks of the Upper Mississippi show a great difference in their structure. They consist, for the most part of hornblende. orthoclase, oligoclase and mica. Quartz, indeed, is generally also present, though often in very small amount. Real granites, disregarding several fine granite-porphyries, are apparently rare, as well as real syenites. These rocks are in many respects interesting and I am preparing a more special work on the subject. The syenite-granites, as I shall provisionally designate them, show numerous changes from hornblende to mica. Many parts are hornblendic on the borders, and others are completely covered over with mica scales. The hornblende is greenish-black, lustrous or earthy, the mica dark-brown, and very glistening.

Quarries have lately been opened in different rocks of this range; they are to be used as building-stone, which, till now, has been confined to the bluish dolomitic limestone of St. Paul and St. Anthony. At St. Cloud a rock has been opened, which shows uniformly a clear-blue color which is derived from the bluish-white, translucent, feldspar. The United States Custom House, in St. Paul, is now partly built of it, and it has also been used a little in smaller buildings. At Sauk Rapids is a similar rock, bearing less quartz and more hornblende, used in the construction of a dam, and for bridge-piers. Further north has been opened for several months a quarry in a very fine decided granite. The greatly predominating orthoclase has, in fresh condition, a glistening white color. Next to that in amount comes the quartz, in grayish grains, and then black mica. This rock is also known as "Watab white granite," and, as soon as the railroad which now only reaches as far as Sauk Rapids, is extended further, will be largely transported to Chicago and St. Louis for large buildings.

In the whole Mississipi valley, from New Orleans to St. Cloud, no crystalline rocks are found, and it has been necessary to use, until now, limestone and sandstone, of rather inferior quality, as material for building. The quarrying of these granite rocks on the upper Mississippi promises for Minnesota in the future to become an important industry.

In a south south-westerly direction appears a similar region of crystalline rocks, exposed on the Minnesota river, where Owen observed granite and syenitic rocks over an extent of 45 miles, between the Cottonwood and Redwood rivers. The region between these points furnishes no outcrops. It consists partly of rolling prairie, and has many lakes on the shores of which water-worn drift-boulders are heaped up. The drift here is very thick; and as the leveling for the building of the Pacific railroad has been carried over it, it is found to constitute a high plateau between the Sauk and Minnesota rivers.

While on one side the hight of the first plateau at the Mississippi reaches 750 to 800 feet above the sea level, and lake Traverse on the Dakota boundary on the other side lies 825 feet above the sea, the line of divide through this high plateau, in the strike of the granite range, is from 1,100 to 1,250 feet above the sea.

According to Whittlesey who has passed repeatedly over the region, there is a connection between the granites of the upper Mississippi and those of the Minnesota. He even goes further, and continues the range northeastwardly along the watershed north of lake Superior. The crystalline rocks observed by him on the upper course of the Rum river, south of Mille Lacs lake, lie in the same prolongation. The slight elevation of the ridges and the thickness of the drift, make it, nevertheless, as yet impossible to demonstrate the connection.

Also Norwood, on the map of the geological survey, in the atlas to Owen's report, extends the line of the crystalline rocks from the upper Mississippi to the Minnesota river. Further, he unites it with the area of granite and crystalline schists in the extreme northern part of the state, which apparently correspond in age and composition to the Laurentian system of Canada. Prof. Hall says that the rocks in the neighborhood of the Redwood river have a gneissic character, and belong to the laurentian system. The metamorphosed sandstones and quartzyte which outcrop in the region and are extended widely over southwestern Minnesota, he places in the Huronian. The relations which these systems sustain to each other are at present not yet ascertained.

Yet all the present indications are that a wide zone of Laurentian rocks goes diagonally through Minnesota, and is accompanied on both sides by Huronian rocks. Until now, the latter were known only to the north of lake Superior. Their presence, however, in southern Minnesota, Prof. Hall has called attention to, where he has also assigned the celebrated "Pipestone Quarry" to the same age. As I shall show in the course of this work, the roofing slates on the St. Louis river must also be reckoned in the Huronian formation.

The interval between the Mississippi and the Red river of the North, amounts to 120 miles. Over this whole extent no outcropping rock has been known with certainty. It is nevertheless probable that the regular succession of Silurian rocks which are displayed on the east of the granites and crystalline schists, returns again on the west. Besides, Owen mentions a spot on the Red river in the neighborhood of the present town of Breckenridge where the Lower Silurian limestone is exposed.* As far as my knowledge goes, this is at the present time the only spot on the Red river, this side the international boundary, where an outcropping rock has been observed. Waterworn pieces of Silurian limestone are, however, of very frequent occurrence in the drift of the Red river valley. Whittlesey mentions Potsdam Sandstone at the falls of Pokegama on the Mississippi in north latitude 47° 15′, northwest of the Laurentian belt. This observation had, indeed, also been made by Owen, and this seems to be the reason why Norwood extends the oldest members of the Silurian on his chart to this place.

A very interesting portion of Minnesota to the geologist, is the eastern; viz.: the shores of lake Superior and the bluffs of the St. Louis and St. Croix rivers. The St. Croix valley which forms the boundary line of Wisconsin, lies, for the most part, in the lowest beds of the Silurian. The principal fossils of the Potsdam Sandstone, and of the lower dolomite are found in this valley. The greatest thickness of this sandstone above the water reaches 170 feet; also the dolomite here reaches the thickness of 100 feet. The beds are apparently horizontal, but in general they have a gentle dip toward the south.¶ Forty-five miles above its mouth the river is contracted, and suddenly its banks take on a different character. In place of the regular contour lines of the sandstone, are rough jagged rocks which outcrop close by the water. Here one stands on the rocks of the celebrated and picturesque "Dalles" or *Felsenhallen* of the St. Croix. The rock has been named by American geologists "porphyritic trap," and it resembles the Norwegian porphyry, which can be seen at Bogstadt on the west side of the Christiana Fiord. Several beds of this rock are cut through by the river, and alternate in the banks with the layers of the Potsdam Sandstone. As yet, I have had the opportunity only to examine this interesting rock over a small area in the neighborhood of the town of Taylor's Falls, near the falls of the St. Croix. Here it is exhibited as a beautiful, quartzless porphyry, or porphyryte, and constitutes the shores of the river and the hill-ranges.

I reached the river from the west side. After I had traveled for hours from St. Paul over the beautiful prairie, suddenly the deep and widely cut valley presented itself right before me. It was a surprising sight. With the greatest regularity of hight, lay several terraces above each other, and with the same hight they were visible also along the opposite bluffs on the Wisconsin side. Taylor's Falls is built on the first terrace, at the foot of which the water boils over the rock crags with the noise of thunder. Right opposite lie the falling ruins of a town in Wisconsin named St. Croix Falls, which owes its hasty bloom and its short, ephemeral existence to the speculation of several enterprising Yankees. Taylor's Falls is what is called in the west, a *lumbering-town*, that is, a place where the lumbermen of the St. Croix buy provisions, and from which, every winter, the men depart for the pineries. The high hills which enclose the place consist of porphyry. Further down the river appears the Potsdam sandstone.

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*No one else has ever seen this outcrop of limestone.—[N. H. W]

The river here does not cut through a single ridge of the crystalline rock, but several diagonal ridges of an area of porphyry. The rock has a pretty uniform character throughout its whole extent. The ground-mass is crypto-crystalline and has a dark-green color. Under the loop can be seen a dark, non-translucent mineral, which in many places is formed in fibrous particles [stangligen partien], and a translucent mineral having the color of olivine. The feldspar crystals, which vary from dark-brown to black, give the rock a characteristic spotted appearance. The feldspar shows very evident striation and twinning, and seems to be the same as that in the brown porphyry of lake Superior. I have found iron-pyrites only as an accessory portion. In several places the rock holds amygdules, the only material of which seems to be white translucent quartz.

The relation of the porphyry to the sandstone beds is interesting. Owen assumes that the latter have been broken through and cut by the trap, although, thereby neither their texture nor their horizontal position have been changed. I cannot confirm that view, but believe the relations of these rocks at Taylor's Falls must require that the porphyry is older than the sedimentary beds.*

Indeed, the layers of the sandstone, wholly undisturbed, as can be seen on both shores, demonstrate that. Furthermore, I observed on the right bank of the river, the rock-profile, seen in Fig. 1.

The sandstone beds here lie horizontal over the porphyry, and continue in this manner over an extended area. They contain a number of fossils which are very beautifully preserved, and prove, even as much as the texture of the sandrock, the insignificant influence of any later outbreak of plutonic rock. A better proof of the greater age of the porphyry was afforded me by a conglomerate which consists of nothing but large water-worn masses of the porphyry, the position of which is between the porphyry and the sandstone. This singular rock, which I saw only in one spot, but in a considerable thickness, descends from the porphyry down to the neighborhood of the sandstone. The water-worn masses, which occasionally reach a considerable size, lie immediately in contact with each other, and have but a slight cementing material between them. Still the rock is very hard, and plainly bedded. The rounded masses and the cementing material consist altogether of more or less decomposed porphyry. Unfortunately the spot where the conglomerate lies under the sandstone, is covered with vegetation. (See Fig. 2.)*

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*Mr Kloss is supported in this by Mr. Sweet, of the geological survey of Wisconsin. [N. H W.]

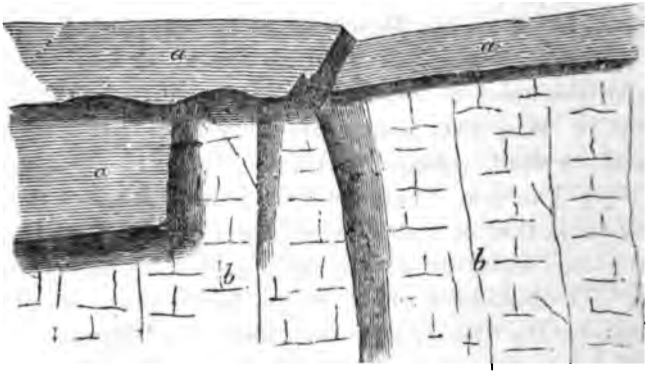

Fig. 1.

a a. Potsdam sandstone; the projecting beds which lie under the first river-terrace, on which Taylor's Falls is built. *b b*. Porphyry.

The character of the different beds which compose the sandstone at Taylor's Falls changes greatly in short intervals. The layers on the Minnesota side form a more continuous, projecting terrace than on the Wisconsin side, where, between the porphyry ranges, are several shallow or flat troughs. Going along the shore, I passed over several small hills, outrunners of the main hill range which forms a belt parallel with the river. Between these small hills lie the layers of sandstone, which descend on both sides level to the middle of the trough. If one ascends the main hill-range, nothing, can be seen of the sandstone. How far the porphyry extends on each side from the river is unknown. In Minnesota, it disappears soon under the drift.

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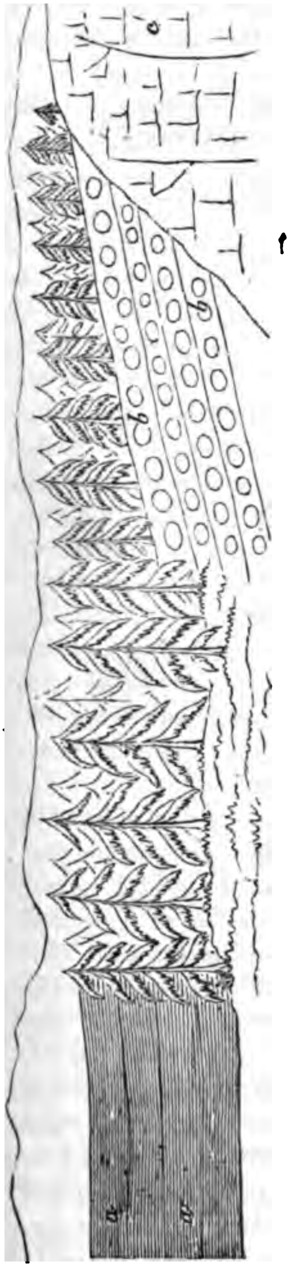
*Whittlesey mentions several spots in the neighborhood of lake Superior where the beds of the Potsdam sandstone lie upon the porphyry, both on the southern shore, at Keweenaw Point, in Wisconsin, and along the northern coast. But yet there can be no doubt that there is a porphyry and melaphyr of the age of the Potsdam sandstone, the layers of which it broke through and upturned. It seems that the outflow of this quartzless porphyry began in Huronian time, and continued through the first part of the Silurian. The inclusion of the sandstone within the porphyry, mentioned by Owen, I have not been able to find at Taylor's Falls, though I have made dilligent search.

Fig. 2.



a a Sandstone; *b b* Conglomerate; *c* Porphyry.

In one of these troughs the rock consists of thin layers of dolomitic marl. It has a clear-gray color, a smooth, conchoidal fracture like limestone, and crumbles in the air, and at the same time it assumes a dazzling white color At the first glance one is apt to take it for a limestone; yet as it does not effervesce at all with acids, it must be principally dolomitic. Further up the river lie dark, iron-stained, firm crystalline layers of a sandy limestone; also the same in thin layers. At the same level on the Minnesota side is a clayey sandstone which does not effervesce with acids. It varies from fine to coarse grained. The latter prevails in the lower portion of the confused mass, and forms a high bank which rests immediately on the porphyry.

All these rocks carry the known species of *Lingula*. Those with the narrow extended beak (*L. antiqua*), and those which are shorter and wider (*L. prisca*) are very abundant, and completely fill some of the layers. Specimens of the former frequently reach five-eighths inch in length. Besides *Lingula* there are also species of *Orbicula* and *Obolus*, and trilobite shields as large as peas (*Conocephalites minutus?*). The shells seem to be distributed in certain belts in the layers; especially is this the case in the coarse, conglomeritic sandstone.*

The varied composition of the beds in their general relations is remarkable. It is true a simple layering one over the other can be seen; on the other hand they all seem to

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*The large wedge-shaped *Lingula* Owen has described as a new species, naming it *L. pinnaformis*, on account of its resemblance to a *pinna*. Nevertheless his illustration of it cannot be distinguished from *L. antiqua*, and in his description he does not bring forward the difference between it and the older species. Another peculiar species which Owen cites from the Taylor's Falls beds is the *Orbicula prima*, a very well defined shell, but which still may be identical with species of *Orbicula* described before from other places. I have no opportunity here to investigate the specific differences, and I shall return to it again later.

occupy the same level; both sandstone and dolomitic shale outcrop opposite each other in the banks of the river at the same hight, and they vary but little from the horizontal.

In order to obtain an examination of the relations of the sedimentary beds to the porphyry and melaphyr-like rocks of the north shore of Lake Superior, I made a trip the past fall to the west end of that lake. The railroad which connects St. Paul with this great American lake was completed the first of August of the former year. An iron track of 155 miles now connects the end of navigation from the Atlantic Ocean with the head of navigation of the Mississippi. Till within a short time it was very difficult to travel from there to the head of Lake Superior—now one rides there in a few hours. The commencement of the autumn storms made it impossible to carry out my plan, and I was compelled to confine my observations to the St. Louis river and the immediate neighborhood of the railroad.

Except a few cuts in the Trenton limestone in the suburbs of St. Paul, the tract of country crossed by the Lake Superior road affords no outcrops of rock till one reaches the valley of the St. Louis river. A vast forest, for the greater part consisting of pine, covers over the whole region. The land is generally flat and swampy. The railroad surveys have established the highest point at 567 feet above Lake Superior, or 1,167 feet above the ocean. This point is 120 miles from St. Paul and 35 miles from the lake. On all sides the plateau is flat, descending gently in both directions.

The first outcropping rock appears in low ridges in the midst of a cedar swamp near the St. Louis river, and at this place occurs the first opportunity since leaving the Mississippi, to behold the bedded rocks.* From here to the lake there is much rock, which offers an extended and little explored field for geological studies. During my short visit I could only make obeervations at a few points. The region is for the most part difficult to travel over. Extensive forests and swamps conceal the rock from view. There are no roads—even between the different stations and new places on the railroad it is necessary to travel on the railroad itself. When the rivers and streams are no longer passable for canoes, it is necessary to scramble from rock to rock in order to be able to look at the neighboring country. A slippery red clay forms the surface covering, wherever the black soil is torn up. Wherever the trees have been cut and the brush burnt, wherever roads have begun to be laid out, it is entirely impossible to travel after the occurrence of a few showers of rain. The whole region bears, more than any other in Minnesota, the stamp of wildness and primitiveness. It has been asked, what can be made of it. It will require immense resources and great labor to make it habitable and productive.

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*The bedded rocks, however, also appear in outcrop at White Bear Lake, at Hinckley and at Moose Lake. [N. H. W.]

The St. Louis river comes from the north, from a region of granite gneiss and mica schist about Vermilion lake, and turns, just before its waters reach Lake Superior, with a sharp angle to the east. Here the railroad company has constructed a high bridge over the river, and a new town is established which has been named Thompson, from one of the officers of the company. The water has broken through the steepey tilted beds, and here forms a long succession of falls and rapids, which in a few miles produce a descent of 370 feet, and are known as the *Rapids of the St. Louis River.* The valley is narrow and shut in by high picturesque cliffs. A dark fir-tree forest covers the hills about —indeed no region of America has reminded me so forcibly of the valleys of the Hartz mountains, and especially of the Bode and a part of the Okerthales.

The rocks also are similar to the rocks of the Hartz. The various strata consist alternately of dark-blue crystalline layers, frequently in the form of roofing slates, and a light firm sandrock or quartzyte which looks like many German graywacke sandstones.[*]

There has been formed a company for the manufacture of the roofing slates. Two quarries have been opened which promise good results. The slate is carried to St. Paul by the railroad; and this may become in the future a profitable industry. Norwood also mentions other slates on the St. Louis which are of a talcose and chloritic nature. Since they are found further up the river, they are in age earlier than the roofing slates. He has also noted a steep dip in the layers in opposite directions, which he ascribed to the injection of igneous rocks. But these he did not find. I also found no crystalline rocks, and I am not of the opinion that at the falls of the St. Louis river any local cause appears that produced the disturbance of the layers. So far as known to me the bedded rocks of northern Minnesota which are older than the Silurian, have been upheaved in the same manner. The beds are broken in a jagged form, and stand out boldly in little rock-islands in the very channel of the river, by which the quartzyte and slaty layers are always easy to distinguish, because the former constitute the elevated parts and the latter the troughs of the outcropping layers, as they are eroded and excavated by the water. No fossils have yet been found in these beds. The inclusions consist of little sulphur nodules. The principal quartzyte beds are penetrated by veins which are composed of quartz and calc-spar. Lines of feldspar are also of frequent occurrence in the slates.

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[*] This quartzyte seems to have been taken for greenstone both by Norwood and Eames.

Probably this whole formation belongs to the Huronian system which on Lake Huron and in the upper Peninsula of Michigan, appears between the Laurentian system and the lower Silurian. The position here exactly corresponds to that horizon. Credner in his work[*] on the pre-Silurian formations of the Upper Peninsula of Michigan, regards as a member of the Huronian a series of clay-slates and quartzyte beds of which the description applies equally well to these rocks. Chloritic slates constitute there as here a portion of the formation. The Potsdam Sandstone lies upon the outcropping beds in Michigan in the same manner as it can be seen to do on these beds further down the river at Fond du Lac. I have not examined this point myself, but quote Norwood's report, as to the facts, as follows: "Not far from the village of Fond du Lac the clay slates and chloritic slates are lost under the conglomerates and red sandstones of Lake Superior, the lower part of the Potsdam system. The latter lie upon the outcropping edges of the slates, with an inclination of six or seven degrees, but dip in the same direction." The place where the two systems lie unconformable to each other does not exceed three miles from the railroad bridge at Thompson, according to the statements of Norwood. From the position of the clay slates, one can infer the presence of the iron-bearing beds which in Michigan characterize the lower part of the Huronian. Perhaps these are the iron beds at Vermilion lake, in the neighborhood of which the metamorphic layers of the Laurentian begin.

Only at one place is the red sandstone to be seen near the railroad in the neighborhood of Lake Superior. This can not be far from the spot where this rock, in connection with the coarse conglomerate, lies unconformably upon the Huronian. The beds here lie nearly horizontal, with a slight inclination toward the south. The upper cuts of the railroad are in red clay before mentioned which, with varying beds of shale, sand and gravel, covers the older formations north and south from the great lake. It embraces a great extent of territory, reaches the height of 600 or 700 feet above the water level, and fills the valleys intervening between the ridges of the clay slates and quartzytes.

At the end of the railroad, where at the present time the streets of the new city of Duluth are being laid out on a steep hillside with an outlay of unprecedented expense, are large exposures of different kinds of crystalline rocks. These form the shores on the left of St. Louis Bay and of the Bay of Superior. The former consists of a widening of the mouth of the river, the latter of a part of the lake shut in by a narrow strip of land, forming a fine harbor. The conformation of the west end of Lake Superior is in the highest degree remarkable. Two small tongues of land project parallel with each from the shore, and are met by narrow points extended in the same way from the Wisconsin shore. Narrow channels or passes only are left so as to admit to the waters enclosed between them. The outermost of these strips of land, Minnesota Point, is six miles long, and has a mean width of only 600 feet. It consists of beach-worn material, or shingle, and it rises but few feet above the level of the water. These pieces have an oblong, generally flattened form, and consist for the most part, of melaphyr, porphyry, and amygdaloid with calc-spar geodes, both large and small.

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[*] This Journal, 1869, p. 528.

Connor's Point in Wisconsin and Rice's Point in Minnesota separate the Bay of St. Louis from Superior Bay. Between them is a channel affording fifty feet depth of water, through which the waters of the St. Louis reach the lake. Superior Bay has its greatest depth near Minnesota Point. Along the opposite shore in Wisconsin it was necessary to build out more than a hundred feet into the bay to find nine feet of water, while on the Minnesota side the water had a depth of 15 to 18 feet. A street from Duluth extends now along Minnesota Point, and the railroad company have begun to cut through it in the neighborhood of the place where it is joined to the mainland, for the purpose of making a fine harbor, sheltered by this natural breakwater. The natural approach, six miles further south, is exposed to much drifting sand, and has also been worked by the people of Wisconsin in order to improve it for an entrance.

In the vicinity of Duluth I have observed three different kinds of rock, but nowhere could I make out the connection which they have to each other. The first, which rises from under the red drift clay and is finely exposed in the vicinity of the railroad depot, the Americans style "granite," to which, however, it has no resemblance. It consists principally of a feldspar of a dirty white color, which is in the form of fine large crystalline grains, which show three cleavage directions. Two of these stand almost at right angles to one another, one of which has a marked greasy luster, and the other a strong glassy luster with fine twinning-lines. The third cleavage direction is only made apparent by fractures which cut both of the others at acute angles, and seems to appear very rarely. I took the feldspar for labradorite. The second ingredient is a dark green to black mineral, of a greasy appearance, which it is difficult to distinguish, because the color is like that of the predominant feldspar. It is indistinctly fibrous, and I took it for diallage or hypersthene. A black, shining mineral, in irregularly shaped grains, which have a strong metallic luster, is sprinkled abundantly in this rock, and stands out beyond all the others on the surface of the weathered crust. On a fresh fracture of the rock it is hard and brittle. Yet under the action of the atmosphere it becomes softer, and then if it is scratched with a knife, small black particles of it remain attached to the blade. Before the blow pipe it behaves like pure magnetic iron. It disintegrates only after a long time, and very seldom is it seen to become oxidized on the outside and changed to a brown ochre. No trace of titanium was discovered.

For the most part this rock has a resemblance to gabbro, or hypersthenyte, although it shows in its whole extent a tolerably uniform structure, and generally a coarsely granular texture. In this rock a quarry has been opened, and the stone is being worked and polished for monumental purposes.

The second rock is cryptocrystalline to compact. In the black groundmass lie brightly glittering needles of feldspar with evident twinning striation. It is exactly like the rock from small veins in the syenite at Sauk Rapids on the Mississippi, and is to be considered, probably, with the greatest degree of exactness, until a more close examination can be made, as a black porphyry or melaphyr.

Next to this a beautiful porphyry forms the first rock at the shore of the lake. This rock is different from the porphyry of the St. Croix river, and in the main resembles the porphyry from Ilfeld in the Hartz. In fresh condition the groundmass is an exceedingly fine-grained mixture of a clear and a dark-brown mineral. The feldspar crystals appear only by reason of their luster, upon the commencement of disintegration of the rock, because of their presenting a somewhat brighter color. Magnetite is sparsely disseminated, and still more sparsely a little pistazite. But the latter mineral is very abundant in the seams, and veins of calc-spar with which the rock is very much intersected. In the same manner also laumontite occurs, and in fact as a pseudomorph after calc-spar. In company with this brown porphyry is found an amygdaloid with a somewhat decayed groundmass. The cavities, which are somewhat elongated, are filled with quartz, calc-spar, chlorite and a decayed iron-bearing mineral. The crystals of feldspar in the porphyry are also in process of decay. A regular variation or interchange between these two rocks is nowhere to be seen. On the other hand the undecayed massive porphyry goes over to the amygdaloid Apparently the decaying of the groundmass and the crystals has gone on step by step with the filling of the amygdaloidal cavities. As already remarked, I have observed the above described rocks nowhere in contact. The works in the city of Duluth will, however, soon furnish fine exposures. The beds of the Lower Silurian which appear further down on the Lake Superior shore, and upon the river, are not found at Duluth nor in the immediate vicinity. Similar reddish-brown porphyries appear to be very widely distributed on the north shore of Lake Superior. The lateness of the season prevented an excursion in a sail boat for observation along the coast. The above described crystalline rocks are grouped together by all American geologists under the name "trap." Whittlesey mentions an augitic, quartziferous and amygdaloidal trap. In other places he speaks of a brown, decayed trap, and of a firm trap, both cut through by dykes of basalt, without giving any further definition of these different rocks.

The Potsdam sandstone forms the north shore of Lake Superior, as well as the south shore. The dip of the beds forms an anticlinal, and the lake consists of a basin of fresh water in the layers of the Lower Silurian. The breaking out of porphyries and melaphyrs, sometimes in the form of dykes and at other times alternating in layers with the sandstone, makes the geological relations very complicated. Along the north shore runs a range of hills which consist of metamorphic and plutonic rocks belonging to the Huronian formation. Five or six miles inland it attains its greatest hight of 600 to 1,000 feet above the level of the lake. Then this terrane is wanting, for the most part, along the coast, and the Silurian beds overlie the Huronian.

A number of streams have their sources in this hill-range, and often winding through the bedded and massive rocks, with rapid descent bear their waters to the lake. They give rise to many outcrops and lay bare the bedding and such like conditions of the melaphyr-masses. Several have attained a positive reputation for their promise of profitable mining of copper, and are valued highly for the future mining of this metal. This is especially the case at the French and Knife river districts.

Whittlesey says that the trappean rocks which bear metallic copper, are of the age of the Potsdam sandstone, and that those that contain the sulphuret ores belong to the Huronian formation.* Also that the cupriferous beds become barren when they change from trap to sandstone. I am still too little acquainted with the appearance of copper on the north shore of Lake Superior, to presume to have an opinion respecting those beds that may be valuable for mining, but I do not believe that the first of these statements has any general validity. I had opportunity to examine somewhat closely some fragments from a vein in a rock designated "trap," from the north shore. It was obtained from a bay between Encampment Island and Kinewabic river, and hence from the area occupied by the rocks of the Potsdam. This place is 30 miles from Duluth, and in the vicinity of Knife river. The rock has a resemblance to a bright, clay-slate, with many strings of calc-spar cutting it in all directions. The calc-spar is crystallized in veins. Its weight certainly indicated that it contained copper or iron. Upon a careful examination can be seen also a sulphide, and black specks of a substance having a metallic luster on the outside, finely scattered through the mass. The latter shows before the blowpipe, the reactions of a mixture of chalcopyrite and pyrite. It contained no native copper, and I could not discover in the wet way any trace of silver.

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*Whittlesey's report of 1866, p. 5.

The above mentioned rock is said to have a thickness of forty feet, and rises perpendicular from the shore, and can be followed inland a short distance. Only the smallest portion of this mass embraces those sulphides and metallic compounds. Similar exposures, showing a little metallic content, a layering and a network of a small mineral vein, are a frequent occurrence in these massive rocks, and point with certainty to a very general diffusion of copper. Yet it has not been found in sufficient quantity to support mining with profit. The best prospects are located at French river, in melaphyrs interbedded with sandstone.

Immediately after the conclusion of a treaty with the Indians in the year 1854, by the terms of which the north shore of Lake Superior was opened to the whites, agents of eastern capitalists explored the region for mineral deposits, Upon superficial observations of men who had but slight acquaintance either with geology or mining, large tracts here were set forth as mineral lands, and as such were disposed of by the government to companies and private individuals. In 1858 the land was surveyed, and many "claims," which had been made before were relinquished. A few years ago a company was formed in Buffalo which began to explore the regions of French and Knife rivers more carefully. A shaft was sunk to the depth of 48 feet, and a quantity of copper ore was found in the deeper lying beds. Nevertheless, these works are now suspended.

At different places on the St. Croix river and its tributaries, copper has been found. Especially is Taylor's Falls and that vicinity, as well as Kettle river, forty miles further north in Minnesota, regarded as a region which some time will be celebrated as a copper.producing district. What has been found thus far consists, in the first place, of large massive pieces in the river-bed, and in the water-worn material of the drift which covers the river banks, and secondly of veins and layers in the porphyry, which produce both metallic copper and copper-glance and copper-oxide, from a heavy but decayed gangue.

Massive, irregularly-shaped, but rounded pieces of native copper have been found in several places in the valleys of streams coming from the north. I saw at Taylor's Falls a heavy specimen weighing fifteen pounds, which was found in the digging of a well several feet below the surface, in the drift. These copper masses in every instance have been exposed for a considerable time to the action of water, and I do not believe that their place of origin should be considered as being in that vicinity. In this opinion I was afterward strengthened, since I found in the drift and gravel which lie on the St. Peter sandstone, as large and equally rounded a piece of metallic copper in the eastern part of the city of St. Paul. It is most probable that along with the drift, metallic copper is brought hither from the southern shores of Lake Superior.*

What I have seen of the copper-bearing rocks of Taylor's Falls, shows the presence of this metal in small quantities near the surface, affording, therefore, some expectation of profit on deep mining. I was conducted to two old shafts and several pits which some time before had been sunk on the summit of a range of porphyry. The shafts were filled with water to the top. The material lying about contained no native copper. It was a porphyry in process of decay, with veins of quartz and feldspar. A six-inch vein of feldspathic, decayed rock had given rise to the exploration. The feldspar vein can be followed for a distance of several hundred feet, and, according to the statement of my companion, under whose instigation the work had been undertaken, had a thickness of two and one-half feet at the depth of twenty. The samples brought from this depth consist of a much changed feldespathic snd calcareous rock. Copper strikes through the mass in slender leaves and threads. Fine black threads, of a black metallic luster, were found to be copper-sulphide, before the blowpipe, and did not exhibit, in the wet way, any content of silver, so far as I could judge. A second place, which had been pointed out by the residents as an outcrop of a copper vein, is at the mouth of a creek which passes down the steep bluffs through the midst of the town. It was a sort of contact-vein between the porphyry and the sandstone. What I could see of the gang-mass in the neighborhood of the very imperfect exposure, consisted of an earthy, much changed amygdaloid. It was asserted to me that copper is to be found, although I saw in the amygdaloid itself not a trace; and I expect that it is one of the erratic pieces from the drift, which is disseminated in the bed of the creek between the larger blocks of porphyry.

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*Masses of metallic copper are found occasionally in the northern drift in Michigan, Wisconsin and Ohio.

Similar feldspar veins as those above mentioned are a very frequent appearance in the porphyry. They always have at the surface only a few inches thickness.

More promising appears the copper outcrop on Kettle river. In 1865 it was pronounced a true vein with a width of 22 feet by Prof. James Hall. I obtained several pieces of the gang. They consist, first, of a brownish dense melaphyr-amygdaloid without apparent crystals. The cavities are filled with quartz, calcite, epidote and copper. It is cut through by numberless fine slits which are filled with the same minerals. The copper is in threads, thin sheets, and also in net-work and knot-like forms, and is always accompanied by quartz, calcite and epidote. The color of the groundmass changes from brown to green, and several specimens approach the color of green, although more distinctly colored through. This is a bluish-green rock, with heavy groundmass, though without evident crystals still carrying the same cavities and amygdaloidal minerals.

A third rock is much changed, mainly feldspathic, but interspersed with a dark mineral. Its prevailing color is derived from copper-salts. The copper is metallic, and is desseminated in extremely fine threads through the whole mass. In this rock appear outcropping veins of copper-glance and earthy malachite. At least there are, among the material derived from this locality, two handsamples which show both these ores in the same groundmass.

The copper-bearing samples of rock from Kettle river, collectively, have the aspect and the characters of vein rocks.

How far the above described appearances may warrant the hope of profitable mining of copper, must be left undetermined till more exact investigations shall have established the extent, the range and the content of copper. The lands of Kettle river have been taken possession of by speculators, in the same manner as those of the north shore of Lake Superior some time before. Here and there examinations have been made in order to learn something of the particulars of the region, yet always in a hasty way and generally by people without sufficient geological knowledge.

From Vermilion lake I have become acquainted with gneisses and firmly crystalline clay slates with much interspersed pyrites, which apparently belong to the Laurentian system. A number of quartz veins cut through these metamorphic schists, which contain a little portion of copper pyrite. The pyrite has been shown to be gold-bearing. A short time ago arose a real *excitement*, of the American type, over Vermilion lake, because it was believed that here had been found a new gold field. There were formed in Chicago, New York, and other cities, several companies; and caravans with furnaces, stamp-works, and amalgamating mills, pressed forward into the wilderness. Large sums of money were soon sunk in Vermilion lake. The government itself laid out a road from Duluth, and the works were in progress till a short time since. Several shafts were dug, among others one 70 feet deep by a New York company. As yet the costs have far exceeded in amount the value of the small quantity of gold which has actually been taken out. I have seen a number of samples of the gold-bearing quartz of Vermilion lake, but have not yet found even a speck of native gold. Likewise I have not been able, in spite of the most diligent enquiry, to find any one who has seen it. There is now no doubt at all that so long as the region remains inhabited by Indians and fur-animals, separated seventy miles from any railroad, the amount of gold taken out cannot pay any one.

The same must be said of the iron ores outcropping in the neighborhood of Vermilion lake, concerning which the reports brought by travelers are very favorable; the profitable mining of which, nevertheless will not be entirely feasible without a railroad connection with Lake Superior. The description which Eames gives of these* agrees with the red iron-rocks of the Huronian on the south shore of Lake Superior in the State of Michigan.** The iron ores from Vermilion lake that have been brought to St Paul consist of a very pure, glittering haematite, of a steel-gray color.

It is probable that further search in Minnesota, on both sides of the zone of Laurentian rocks, will show the presence of Huronian iron ores. There have this year new surveys been made along the branch line of the Pacific railroad which runs along the Mississippi, extending further toward the north. I hope by this means to learn of interest-

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*Report of Henry Eames 1866, p. 11.

**Credner: *Zeitschr, d. Deutsch, geol. Ges.* 1869 s. 527.

ing facts concerning the relationships of the Laurentian, Huronian and Silurian rocks in the upper portion of the Mississippi valley.

Besides the rocks and formations described above, I have marked upon the plate (Taf. VIII.) a small area south from the St. Peter river lying between Laurentian and Huronian rocks. This small area belongs, according to the investigations of Prof. Hall, to the Cretaceous formation. It is an old fresh-water basin in which has been found a considerable quantity of brown coal. As I have not examined the region myself, and I know nothing further about it, I shall give here nothing further concerning its appearance. Much effort has been made continually to find stone coal, or brown coal, in Minnesota, because in a large part of the State there is a lack of forest, and therefore of fuel. The small Cretaceous area on the Cottonwood river is as yet the only spot where real coal-bearing beds have been found in outcrop. All former discoveries have proved to be "drift coal," or erratic pieces in the diluvium.

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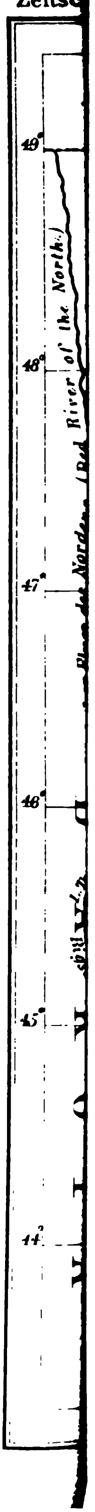

VII.

CHEMISTRY.

ANALYSES BY PROF. JAMES A. DODGE.

Analyses have been reported by Prof. Dodge of substances for the survey, from Nos. 69 to 83, both inclusive, of the Chemical Series. This list is from the following localities:

No. 69. Efflorescence on the surface of the ground (" alkali "), Sec. 14, Iona, Murray Co. Mus. Reg. No. 3936.

No. 70. Light-colored pipestone, or "chalk-rock" so-called, Palisades, Minnehaha County, Dakota, two rods east of the dam, in the plane of the pipestone. Mus. Reg. No. 3896.

No. 71. Light blue calciferous sandrock, from the lower part of the quarry of Maxfield and Mather, Mankato, showing non-hydrated (unoxidized) natural condition of the deeper beds of the Shakopee formation.

No. 72. Rice Point granite, No. 1 of the Survey Series. To determine the alkalies and the lime of the feldspar.

No. 73. Rice Point red granite, No. 1 B, of the Survey Series. To determine the alkali of the feldspar.

No. 74. Limestone, supposed to be hydraulic the equivalent of the shale layer at Maxfield's quarry, at Mankato. From the quarry of J. R. Beatty & Co., near Mankato.

No. 75. Light-colored, nearly white clay, supposed to be kaolinic, from the same place as the above, but probably Cretaceous.

No. 76. Water from Mille Lacs, needing filtering.

No. 77. Water of the Mississippi river from above Minneapoli about one mile, right bank.

No. 78. Water of the Mississipi river from below Minneapolis about one mile, right bank.

No. 79. Limestone of the Hudson river Group at Clinton Falls, near Owatonna, quarry of Lindersmith & Son.

No. 80. Limy sediment in a layer in the till, on Nicollet Island, Minneapolis.

No. 81 Ore supposed to contain copper, from near Beaver Bay. From T. 56, R. 8, S. W. ¼ Sec. 22, on North river, Wieland Brothers.

No. 82. Lime City limestone, Filmore county. Mus. Reg. No. 4099.

No. 83. Concretionary Cretaceous. Two Rivers, Morrison county. Mus. Reg. No. 4561.

ANALYSES.

No. 69, Chemical Series. Museum Reg. No. 3936.

"*Alkali*" Efflorescence, with soil adhering.

Whole substance powdered, air-dried, digested with water:—

	Per cent.
Dissolved by water	48.6

The residue digested with hydrochloric acid:—

Dissolved additional	3.1
Total dissolved matter of the whole substance	51.7

Portion dissolved by water contained:

MgO, 22.5 per cent SO_3, 44.8 "	67.3 per cent. sulphate magnesia
Water	not determined
SiO_2, Fe_2O_3	traces
Organic matter	traces

The sulphate of magnesia was therefore not present in the form of Epsomite, as MgO, SO_3, $7H_2O$.

Would require MgO, 16.26 per cent. " " SO_3, 32.52 "	48.78 per cent.
" " $7H_2O$	51.22 "

Portion (additional,) dissolved by hydrochloric acid contained:

SiO_2	18.6 per cent.	
Fe_2O_3, Al_2O_3 and phosphoric acid	58.3 "	(mainly Fe_2O_3)
MgO	20.5 "	
CaO	traces	
Organic matter	"	
Alkalies	"	

The residue, insoluble in H Cl, fused with carbonate of soda, gave:

SiO_2	75.8
Al_2O_3	11.1
Fe_2O_3	2.1

CaO	.86
MgO	.66
Organic matter	considerable
Alkalies	trace

This residue was in fact simply a dark soil, with fragments of roots &c.

Carbonic acid, and chlorides were almost wholly absent from the substance. Potash and soda were present in slight traces. Lime also was present in slight traces.

No. 70, *Chemical Series*, Museum Reg No. 3896.

SiO_2	50.4	per cent.
Al_2O_3	33.3	“
Fe_2O_3	2.8	“
CaO	0.6	“
MgO	0.17	“
Na_2O	3.5	“
K_2O	0.6	“
H_2O	9.6	“
	100.97	

The composition agrees fairly with that of Catlinite, which the rock resembles in physical properties except color, being white with tinge of yellow.

No. 71. Rock, a limestone of light-gray color, containing silica.

Ten grammes of the powered and dried mineral were digested with hydrochloric acid; a residue was left which weighed 1.552 gms., making 15.52 per cent. of the rock; the portion dissolved was therefore 84.48 per cent.

Analysis of portion dissolved by hydrochloric acid:—

Fe_2O_3 with small amount of Al_2O_3 and SiO_2	3.14	per cent., being	2.65	per cent. of whole rock.
$CaO\ CO_2$	55.47	“ “	46.86	“ “ “
$MgO\ CO_2$	39.73	“ “	33.56	“ “ “
	98.34		83.07	

Analysis of portion left undissolved by hydrochloric acid:—

SiO_2	-	77.9	per cent., being	12.1	per cent. of whole rock.
Al_2O_3	-	19 24	“ “	2.99	“ “ “
CaO	-	.34	“ “	.05	“ “ “
MgO	-	.12	“ “	.02	“ “ “
Alkalies,		traces.			
Organic matter,		traces.			
		97.60		15.16	

It appears, therefore, that the rock is a magnesian limestone, with about 12 per cent. of silica and somewhat over 2¼ per cent. of oxide of iron.

No. 72. A granitic rock of bluish-gray color, from which the feldspathic portion was selected (by mechanical means) as clean as possible. This portion, which was still, however, not wholly unmixed with other constituents of the rock, was analyzed with the following result:

SiO_2	49.78	per cent.
Al_2O_3 and Fe_2O_3*	32.36	“
CaO	11.55	“
MgO	1.43	“
K_2O	.41	“
Na_2O	3.39	“
H_2O	1.83	“
	100.76	

No. 73. A granitic rock of reddish color; this was analyzed as a whole, the grain being too fine to permit mechanical separation of its constituents.

SiO_2	75.78	per cent.
Al_2O_3	11.09	“
Fe_2O_3	2.09	“
CaO	.86	“
MgO	.65	“
K_2O	1.06	“
Na_2O	6.43	“
H_2O	1.82	“
	99.78	

No. 74. Rock a siliceous limestone. Digested with hydrochloric acid, a residue was left amounting to 19.67 per cent., the dissolved portion was therefore 80.33 per cent.

Analysis of portion dissolved by hydrochloric acid:—

SiO_2	.27	per cent.,	being	.21	per cent.	of whole	rock.
Al_2O_3	.15	“	“	.11	“	“	“
Fe_2O_3	3.03	“	“	2.43	“	“	“
CaO CO_2	55.62	“	“	44.68	“	“	“
MgO CO_2	39.13	“	“	31.59	“	“	“
	98.21			79.02			

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*Note.—The amount of oxide of iron is quite small.

Analysis of portion not dissolved by hydrochloric acid:—

SiO_2	78.27	per cent.,	being	15.29	per cent.	of whole	rock.
Al_2O_3	18.33	"	"	3.61	"	"	"
CaO	.48	"	"	.09	"	"	"
MgO	.23	"	"	.04	"	"	"
Alkalies	traces.						
Organic matter	traces.						
	97.31			19.03			

A determination of water in the dried powder gave 4 per cent. (of whole rock.)

This is therefore a magnesian limestone, containing about 15 per cent. of silica, and but a moderate quantity of oxide of iron. It would appear likely to make a good hydraulic lime. No. 71 might also serve that use.

No. 75. A very light-colored clay, from Mankato. This was pulverized, without grinding up the particles of gritty matter that were to some extent intermixed with it; the powder was then mixed with distilled water, the suspended portion poured off and allowed to settle for a day or two; the settled portion was then collected, dried at 212°, and submitted to analysis by the common methods for silicates.

SiO_2	87.7	per cent.
Al_2O_3	7.24	"
Fe_2O_3	traces	"
CaO	.67	"
MgO	.07	"
K_2O	.49	"
Na_2O	3.17	"
Organic matter	traces	
Water	traces	
	99.34	

No. 76, of the Chemical Series. As received this water showed some turbidity, and had deposited a brownish sediment in the can. It was filtered, and a large quantity evaporated. In the course of this evaporation a similar brown flocculent matter separated out. It consisted of organic matter mixed with oxide of iron.

The residue from evaporation was submitted to analysis, and found to consist of the following substances, in the amounts stated:

Silica...........	3 85	per cent.	of total	residue from	evaporation.
Carb. lime.......	28.07	"	"	"	"
Sulph. lime.....	.95	"	"	"	"
Carb. Mag......	28.62	"	"	"	"
Oxide of iron....	1.26	"	"	"	"
Carb. potassa...	3.03	"	"	"	"
Carb soda......	11.09	"	"	"	"
Chl. sodium	.74	"	"	"	"
Organic matter..	22.40	"	"	"	"

The weight of the residue from a given quantity of water was found to be in the proportion of about 10 grains to the gallon. Reckoning the above specified constituents in grains per gallon, I found:—

Silica....................................	.2499	grains	per gallon
Carbonate of Lime..........................	3.1355	"	"
Sulphate of Lime...........................	.1051	"	"
Carbonate of Magnesia......................	3.1589	"	"
Oxide of Iron..............................	.1389	"	"
Carbonate of Potash..........................	.3346	"	"
Carbonate of Soda..........................	1.2241	"	"
Chloride of Sodium.........................	.0817	"	"
Total Mineral matter..................	8.4287	"	"
Organic matter.............................	2 4458	"	"
Total residue..........................	10.8745	"	"

In regard to the above figures, it is to be noted, that the amount of solid residue taken as a whole is not great, compared with that from many waters in this State; that the amounts of lime and magnesia (existing in the water as bicarbonates,) are but moderate; that sulphates and chlorides are almost wanting, and that the water is *alkaline*, by virtue of the presence of the carbonate of potash and soda. Upon concentration of this water, in a platinum dish, a ready and decided test is obtained by litmus and turmeric papers.

Further, it was found that nitrates and phosphates are absent.

No special examination of the organic matter was made.

Nos. 77 and 78 of the Chemical Series.

MINNEAPOLIS, MINN., March 13, 1882.

Prof. N. H. Winchell:

DEAR SIR:—I hereby report the results of my analysis of the water of the river made at your request with a view to determine what difference might show itself in the water above and below the city. Two samples were procured, at the same time and in the same manner, the one (No. 77,) at a point on the west bank about half a mile above the upper bridge, (Plymouth Ave.,) and above all apparent considerable sources of contamination, the other (No. 78) at a point, also on the west bank, below the brewery, at the small grove near the Fair Grounds.

These two samples of the river water have been submitted to precisely the same course of analysis. A quantity of each sample, amounting to eight litres—somewhat over two gallons—was evaporated to dryness, and the composition of the residue ascertained. In addition, the method of determining organic matter in water by the distillation process of Wanklyn, was applied to each sample of water.

The samples of water were procured by me about the 20th of December. They were immediately filtered, and kept in suitable glass vessels; that part of the work of analysis which needed to be done without delay, in order to avoid the effects of change in the water by keeping, was done. The remainder has been carried on with other work during great part of the winter.

1. Composition of the residue from evaporation of the water of the river above Minneapolis:—

Silica. SiO_2	.78256	grains	per gallon
Carbonate of Lime, $CaO\ CO_2$	6.39532	"	"
Carbonate of Magnesia $MgO,\ CO_2$	3.15307	"	"
Carbonate of Iron, $FeO\ CO_2$	.05504	"	"
Chloride of Sodium, $NaCl$	.16352	"	"
Potash, K_2O	.10162	"	"
Soda, Na_2O	.17462	"	"
Sulphuric Acid, SO_3	.16445	"	"
Nitric Acid, N_2O_5	traces		
Total Mineral matter in the residue	10.99020	"	"
Organic matter	1.40228	"	"
Total Min'l & Organic m't'r in residue	12.39248	"	"

2. Composition of the residue from evaporation of the water of the river below Minneapolis:—

Silica, SiO_2	.97090	grains	per gallon
Carbonate of Lime, $CaO\ CO_2$	6.13722	"	"
Carbonate of Magnesia, $MgO\ CO_2$	2.42827	"	"
Carbonate of Iron, $FeO\ CO_2$	.15560	"	"

Chloride of Sodium, NaCl..............	.18408	"	"
Potash, K_2O........	.15826	"	"
Soda, Na_2O............................	.15126	"	"
Sulphuric Acid, SO_3.....................	.17462	"	"
Nitric Acid, N_2O_5.......................	traces,more than in No.1		
Total Mineral matter in residue......	10.36021	grains	per gallon
Organic matter..........................	1.96219	"	"
Total Min'l & Organic m't'r in residue	12.32240	"	"

3. Results of Wanklyn's method for determining the organic matter, in water from above city:—

Free Ammonia,	.0175	milligrammes,per litre,
	or .0175	parts per million.
Albuminoid Amonia,	.0625	mgm. per litre,
	or .0625	parts per million.

4. Results of Wanklyn's method for determining the organic matter, in water from below city:—

Free Ammonia,	.0266	parts per million.
Albuminoid Ammonia,	.1550	parts per million.

I would like to call attention to the following points: First, the amount of matter, mineral and organic together, differs but little, in the residues from the evaporation of the two waters; but the amount of organic matter in the water from below the city is appreciably larger than in the water from above; on the other hand the amonnt of mineral matter is larger in the water from above. This latter result was to me wholly unexpected, but I am certain of its correctness. The water of the river below contains a little less carbonate of lime and magnesia than the water above. The difference, however, is wholly immaterial in a practical point of view, and may be accounted for by the influx of several creeks which bring in softer water than the river; also by the consideration that what lime finds its way into the river from factories and from masons' use, may serve to precipitate a small part of the carbonate of lime and magnesia that are in the river. Second, the difference in the amount of organic matter in the two samples, is quite material, in sanitary respects. The results of the determination of free ammonia and albuminoid ammonia are such as to place the water from above the city under the head of good drinking water, while that from below would be excluded from that class. It is to be observed that the water below shows somewhat more of all ingredients except lime and magnesia. In the case of nitrates, a quantitative determination could not be made. Qualitative tests showed somewhat more in the water below.

Very respectfully,
JAMES A. DODGE.

Chemical Series, No. 79, a Siliceous Limestone.

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Silica	2.88	Silica	10.74
Oxide of iron	2.56	Oxide of iron and alumina	3.80
Calcium carbonate	58.09	Lime	traces
Magnesium carbonate	19.90	Magnesia	.63
Alkalies	traces	Alkalies	traces
Sulphric acid	traces	Organic matter	not determined
	83.43		15.17

Chemical Series No. 80.

Calcareous rock, with iron pyrites distributed through it, and having a vein mainly of pyrites.

Main rock:—	Vein:—
Assayed ½ oz. gold $\frac{1}{10}$ oz. silver } per ton.	Assayed 1 oz. gold $\frac{1}{10}$ oz. silver } per ton.

Chemical Series No. 81, Calcareous Layers in Drift, Nicollet Island.

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Oxide of iron	2.69	Silica and silicates	35.53
Calcium carbonate	55.55		
Magnesium carbonate	4.95		
	63.19		

Chemical Series No. 82, Limestone.

Soluble in hydrochloric acid:—	per cent. of whole rock.	Insoluble in hydrochloric acid:—	per cent. of whole rock.
Oxide of iron	.73	Silica, etc	4.57
Calcium carbonate	70.53		
Magnesium carbonate	23.49		
	94.75		

Chemical Series, No. 83. A siliceous rock, to a great extent soluble in hydrochloric acid.

The rock was analyzed as a silicate, and its composition found to be as follows:—

Silica	19.81	per cent.
Alumina	52.43	"
Oxide of Iron	1.32	"
Calcium Carbonate	1.64	"
Soda	0.44	"
Water	23.23	"
	98.87	

In appearance this rock bears a considerable resemblance to compact gray limestone. Its hardness is a little less than that of limestone.

VII.

THE GEOLOGY OF THE DEEP WELL DRILLED BY C. C. WHELPLEY AT MINNEAPOLIS, AT THE "C" WASHBURN MILL.

BY N. H. WINCHELL.

(READ BEFORE THE MINNESOTA ACADEMY OF SCIENCES, JANUARY, 1882.)

I have just seen for the first time the record and drillings of this well (Dec. 1881), though the well was drilled some years ago, and the record and drillings were preserved at my request. The set sent me by Mr. Whelpley was lost in some way by being miscarried. The set on which these notes are based was encountered in the late moving of the effects of the Academy to new rooms, and I take the first opportunity to bring before the Academy what I deem important information concerning the strata that underlie the city, derived from an examination of this tube.*

In order to appreciate the bearing of the new facts on the geology of the region, it will be necessary to review briefly the former knowledge we had of the strata underlying the city. In the report of the geological survey for 1876, will be found a description of the geology of Hennepin county, by which it will be seen that the strata of the Lower Magnesian formation, represented by the Shakopee limestone extends under the St. Peter sandstone, occupying, conjecturally the surface of the western and central parts of the county. In the same report is a section of the deep well drilled in East Minneapolis, as furnished by the city engineer, Col. J. B. Clough, the designations of the strata being his, or of the party who drilled the well. The drillings of that well were not preserved, and it was found impossible to verify the designations by a comparison with them. It will be seen by that section that a "red limestone" was reported as penetrated, beginning at 234 feet and extending a depth of 102 feet farther. Under this is reported a "gray limestone." Below these, followed alternating, gray and white sandstones and shales with some sandy limestones, to the depth of 1074 feet. At that point the drill entered a red shale and sandstone which seems to have varied very little, if any, up to the time the work ceased at a depth of 1421 feet. This red shale and sandstone is the same formation in which the deep well stopped at Belle Plaine, and at other places in the State, the equivalent of the red shales of the Lake Superior region, the probable true Potsdam of the northwest. The well reported by Mr. Whelpley only goes to the depth of 205 feet, but as the drillings are presented with the recorded designations, it throws light on the geology of this part of the State which has a bearing on the proper interpretation of the deeper well of 1874. It is as follows, as given correctly by Mr. Whelpley:

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*The drillings from the well were exhibited in a glass tube about three feet long, in the order of their places in the strata.

1.	Peaty black soil	2	feet
2.	Drift sand and stones	8	"
3.	Limerock, (gray and blue)	24	"
4.	Blue clay, (shale)	2	"
5.	White sandrock	44	"
6.	Yellow sandrock	7	"
7.	White sandrock	41	"
8.	Yellow sandrock	3	"
9.	Fine, white sandrock	22	"
10.	Yellow sandrock	5	"
11.	White sandrock	2	"
12.	Pipestone clay, reddish brown	2	"
13.	Coarse, white sandrock, (water to top of ground)	21	"
14.	Coarse, gray sandrock	17	"
15.	Hard, gray sandrock	4	"
16.	Red rock, (grit) penetrated only	1	"
	Total depth	205	"

On comparing these records it will be seen that the former well penetrated the two feet of pipestone clay at about the depth of 197 feet (of its own record,) without any notice being taken of it. This supposition is more probably correct than that this clay was not encountered, judging from a general looseness of designation that seems to pervade the earlier part of that record, and from the nature of the stratum and the proximity of the wells to each other, (about one-third mile apart). Furthermore, the record of white sandrock continues alike in each well down to the depth of 204 feet in one, and 234 in the other, which, calculating from the top of the Trenton limerock, makes the "red rock" in one well (Whelpley's) appear at 195 feet, and in the other at 191 feet. This shows that there could have been no such disturbance in the bottom of the ocean as to have changed the detritus and caused the omission of the pipestone clay in the East Minneapolis well; which is also indicated by the fact, that the pipestone clay was extensive enough to confine under hydrostatic pressure, a volume of water which rose at once to the surface of the ground on being pierced by the drill.

All the sands underlying the blue clay below the Trenton limestone are essentially the same in character, being composed of rounded grains of pure quartz. These grains differ in size, the largest being about as large as a mustard seed, and the smallest too minute to distinguish with the unaided eye. They differ in color somewhat, passing from a pure limpid glass to snowy white, and to a buff color, and to a smoky gray. These colors are not due to the cement in which they were enclosed, but to an actual difference in the quartz itself. This difference of color implies some change in the source of the material, and suggests the enquiry whether that change were not in the waters of the ocean rather than on the land. On the supposition that this pure quartz were the result of chemical precipitation, these different colors in the same formations are easily accounted for by such changes as may have occurred in the ocean by shifting currents, allowing the mingling of certain other substances in solution, with the precipitated silica so as to stain it as it is. On the supposition that this sand is derived from the preexisting land as a sediment of detritus, it is very difficult to understand how such a source of pure silica, almost absolutely free from other sand and impurities, could be obtained and disseminated as widely as this sand is known to extend, and to change its inherent color from time to time.

The pipestone clay No. 12, is undistinguishable from similar clay and shale seen in the Potsdam formation at Fond du Lac. It is somewhat schistose in one of the fragments, and also has spots of green similar to the green spots seen in the same clay at Fond du Lac. In its schistose character it resembles some of the schistose, soapy, clays seen in the formation at Baraboo, Wisconsin, and at Sioux Falls, Dakota. It generally is a shale and has an angular fracture. In the midst of one of the fragments is seen a little grit cemented by the same substance that cements the red rock of No. 16.

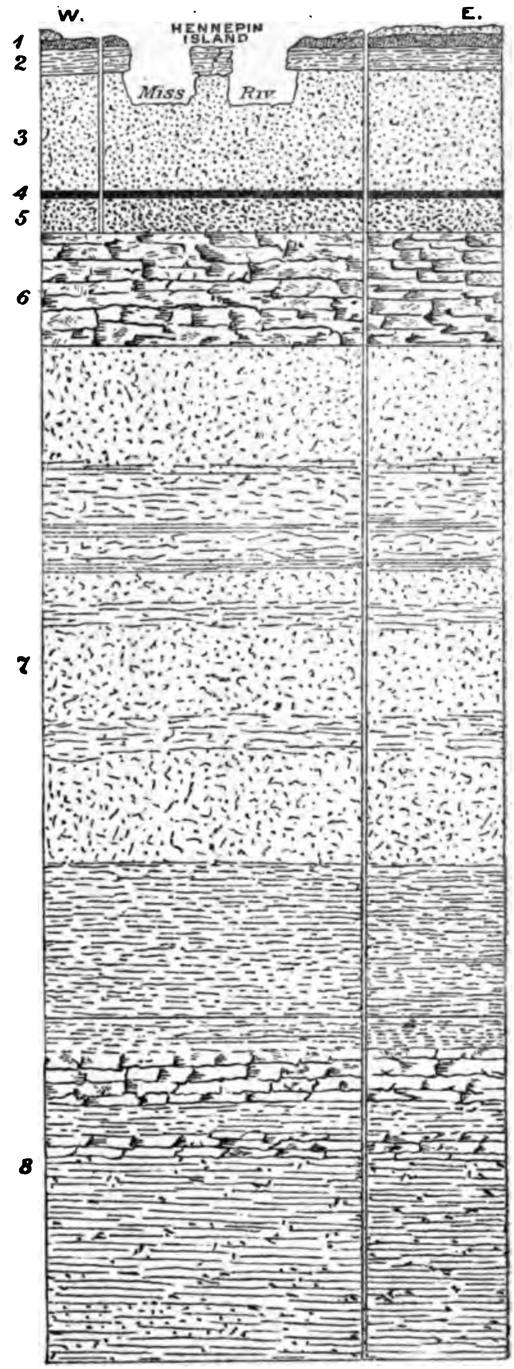
No. 16, which is the red limestone, so-called, of the East Minneapolis well, has not any of the qualities of a limestone. It is a coarse, red grit-stone, or arenaceous felsite, the grains being pure white silica, and the cement itself an amorphous red feldspathic substance seen to result in many cases from incipient metamorphism of the shales of the formation, disturbed by igneous eruptions, at Lake Superior. In other words it is a layer of the red quartzyte formation seen at New Ulm and at Baraboo, Wisconsin. The East Minneapolis well found this layer to be 102 feet thick, and to be underlain by other sands and shales, some of them being blue and gray to the thickness of 722 feet. Thus we find an interbedded red quartzyte in the Potsdam formation similar to those seen in the same formation in the Black Hills, and in several other places in the Rocky Mountain region.

I wish to call attention particularly to the occurrence of the red pipestone clay No. 12. This shows that the continuance of the disturbing causes, centering in and radiating from the region of Lake Superior, were still able to send a muddy agitation through the ocean sufficient to deposit a copious red sediment to the exclusion, almost entirely of the white quartz. This is within 127 feet of the bottom of the Trenton formation, and as nothing but white sandrock separates it from the Trenton formation, it demonstrates the absence of the entire Lower Magnesian formation. Thus we find the Trenton brought into contact with continuous white sandstone beds, which are shown, at least below 127 feet, to belong to the Potsdam formation. How much of this 127 feet may be of the St. Peter it is impossible to state, because there is no change in the character of the sandrock, but it is just as reasonable to suppose that the Potsdam continues upward to the Trenton at Minneapolis, in the same manner as it is reported to in Eastern Michigan, as to suppose the St. Peter sandrock, which is well known to exist between the Shakopee and Trenton further south, is brought on to the Potsdam, because in both cases it necessitates what might be styled an invisible unconformability between the Potsdam and the next overlying formation.

The question naturally arises—in what part of the Potsdam formation do these white sandstone layers belong? The answer must be, near the top, and probably quite at the top. This is evident from three considerations: First, there is an immense thickness of red sandstones and shales underlying them, as demonstrated by the East Minneapolis and by other wells in the State, which must belong to the formation, and which are the equivalent of the Lake Superior red shales and sandstones. Second, but a small thickness of sandstone supervenes before the Trenton formation is found overlying. These upper light sandstones must be older however than the layers which at Taylor's Falls lie unconformably on the trap rock, since there the formation had progressed far enough to admit of animal life, and dolomitic beds; and it is likely that the period of upheaval exhibited about Lake Superior had entirely ceased before the deposition of the Taylor's Falls sands and dolomites, setting off those and all succeeding layers into an era of comparative quiet.

In order to make the relations of these wells to each other, and to the geology of the region more evident, they are placed beside each other in perpendicular section, in figure No. 3.

FIG. 3.



Explanation of Figure 3.

1.	Drift	10	feet.
2.	Trenton limestone	24	"
3.	Light, crumbling sandstone (St. Peter?)	125	"
4.	Brown-red pipestone clay	2	"
5.	Potsdam sand	42	"
6.	Red quartzyte, Potsdam	102	"
7.	Light-colored Potsdam sand and shales	722	"
8.	Red Potsdam sandstone and shales, at least	347	"

VIII.

PAPERS ON THE CRUSTACEA OF THE FRESH WATERS OF MINNESOTA.

BY C. L. HERRICK.

I. *Cyclopidæ of Minnesota with notes on other Copepoda.*

II. *Notes on some Minnesota Cladocera.*

III. *On Notodromas and Cambarus.*

[NOTE.—The author feels it but justice to himself to state that part of the material here has been in its present form for some time. The work was begun in 1879.]

I. CYCLOPIDÆ OF MINNESOTA, *with notes on other Copepods.*

CALANIDÆ.

It seems that recent authors have sufficient ground for uniting the families *Calanidæ* and *Pontellidæ* under the single name; the value of these terms as subfamily names even may be questioned.

The family is represented in our limits by two genera and by three, or doubtfully more species.

The fifth pair of feet furnishes, by its modifications, the best criteria for distinguishing genera and species.

Genus DIAPTOMUS, Westwood.

Body elongated, compressed; head destinct from the thorax, anterior antennæ 25-jointed, those of the male geniculate on the right side; posterior antennæ and mouth parts as in *Calanus;* inner branches of all the swimming feet three-jointed except the first, which is two-jointed; fifth foot consisting of two unequal branches, prehensile; abdomen of male with five-joints, of female three-jointed.

DIAPTOMUS CASTOR.

(Plate I, figs. 1-7, Plate II, figs. 1-2, 16.)

Bibliography.

Monoculus castor, *Jurine.*

Cyclops castor, *Desmarest*, *Baird*, Mag. Zool. and Bot.

Cyclops cæruleus, *Muller*, *Latreille*, *Bosc.*

Monoculus cæruleus, *Fabricius*, *Manuel*, *Gmelin.*

Cyclops lacinulatus, *Muller*, *Ramdohr*, *Latreille*, *Bosc*, *Baird*, Trans. Beow. club.

Monoculus lacinulatus, *Manuel*, *Gmelin.*

Cyclops rubens, *Muller*, *Latreille*, *Bosc*. *Baird.*

Diaptomus castor, *Westwood*, *Baird*, *Baker.*

Cyclopsina castor, *M. Edwards*, *Baird*, *Claus.*

Glaucea rubens, *Koch*, Deutschlands Crust.

Glaucea cærulea, *Koch*, " "

Diaptomus castor, *Baird*, Brit. Entom.
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The above bibliography is complete only up to a comparatively recent date; many notices may be found in recent literature.

The species which, after careful study, has been considered identical with the European *D. castor* is that described previously as *D. longicornis* with the remark that it might prove too near *D. castor*. *D. sanguineus*, Forbes, seems to be the same thing nearly. If the amount of variability admitted by Brady to prevail is allowable I see no reason for separating this species. It is very variable as to size and coloration, and even in the configuration of some of the parts, as antennæ, etc., a certain amount of latitude is to be given; (See plates of Claus, Zur Anatomie und Entwicklungs-geschichte der Copepoden Arch. f. Naturg. XXIV Jahrg., B I.) $\frac{14}{100}$-$\frac{18}{100}$; cm. in length. The following points are variable:—length of caudal stylets, structure and thickness of male geniculating antenna, size of claw of fifth male foot and spinous armature of feet. How far such variations may extend and how much they are dependent on peculiarities of habitat, etc., farther study must demonstrate. Some interesting facts meanwhile are suggestive. A second and gigantic form which may be known as

Diaptomus giganteus.

(Plate II, figs. 3-11-15.)

with the reservation that it is doubtfully of more than varietal value, was found under such circumstances as to suggest that it might be only a curiously magnified condition of *D. castor*. It is known to occur only in a small marshy pool of about two square rods extent and which annually dries up nearly completely. A few yards away is a second pool of a somewhat greater size and which less frequently dries up in summer. These two pools within the memory of the writer were united, but in the gradual dessication which has been observed in all Minnesota, they have been isolated. The former pool in June was found to contain *mature* males and females of the *D. giganteus only*, few other copepods being present, while the other pool contained *all stages* of the common *D. castor*. There are no neighboring waters, the nearest being half a mile, and that (L. of Isles) has only *D. castor*.

The smaller pool soon completely dried up so that this form was, for the time, exterminated. The conclusion seems almost resistless that the stagnation incident to evaporation produced circumstances favorable to the development of this enlarged form. At any rate it is an interesting fact in local distribution.

This variety is $\frac{3}{10}$ cm. long or more, and is much the largest fresh water copepod known to me; it is a deep red in color and very compactly framed. Although so much larger than *D. castor*, it is almost impossible to find any structural differences. The male fifth foot differs somewhat, but mainly in the enlargement of one part at the expense of the others. The thorns on the feet are strongly pectinate and the larger ones bear short spines instead of bristles.

Diaptomus armatus, sp. n.

(*See accompanying cut.*)

A second form is imperfectly known, but presents some clearly marked distinctions which may have specific value.

Length about as *D. castor*; body slender; antennæ reaching base of abdomen only; female differing otherwise but little from *D. castor* (?); male considerably smaller; caudal stylets narrow; antennæ peculiar, shorter than the body; thickened portion of the geniculate antenna short; two last joints very short; one preceding the second long, bearing a hook at end; fifth foot with a very long claw to longer ramus (nearly as long as the ramus itself) with a tooth on the inner margin near the base, not perfectly arcuate, reaching, when extended, to end of caudal setæ.

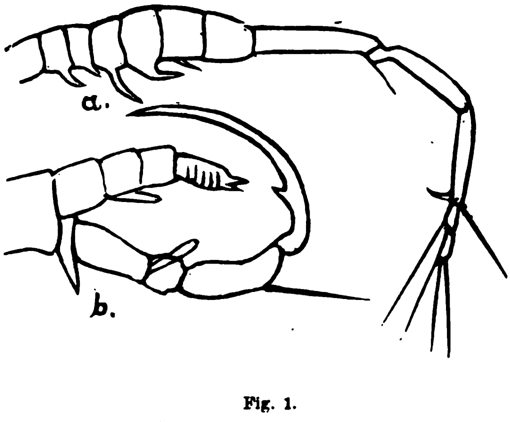

Fig. 1.

Diaptomus armatus.

a. part of male antenna. b. fifth foot of male.

Genus POTOMOICHETOR,* Gen. nov.

Cephalothorax six-jointed as in *Diaptomus*, but with the distal segment more evident; abdomen, in the male, five-jointed, *in the female*

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*River inhabitor.

four-jointed; antennæ *twenty-four* jointed, the right geniculated as in *Centropages* (=*Ichthyophorbia*); first pair of feet with the rami *both three-jointed*, like the following; feet of the fifth pair, in the female, like the preceding, but with a spine of the joint preceding the terminal one enlarged and divaricated somewhat as in *Centropages*; in the male, the right with a two-jointed outer ramus, the terminal joint of which is spined and bears near its base a blunt expression of its inner margin; outer ramus of left foot three-jointed, armed with unequal spines; inner branches smaller, similar, three-jointed; the terminal joint bearing curved spines; ovary and testes as in *Diaptomus*, with which the mouth parts agree in the main; eyes medium, confluent; no lower or secondary eye-spots.

POTOMOICHETOR FUCOSUS, sp. nov.

(Plate II, Figs. 12-14. Plate III, Figs. 1-8, 13-14.)

Rather slender, and in size, as well as general appearance, resembling the smaller forms of *Diaptomus castor*; antennæ rather stout, reaching but little beyond the feet, appendaged as in D. *castor*, in the male strongly geniculated, but somewhat variously so; the six joints preceding the terminal four are thickened; those preceding the joint or hinge are arcuate on the distal margins; the secondary antennæ are about as in Diaptomus; mandibular palp two-branched; the outer three-jointed, the inner two-jointed; the terminal joint of the shorter branch bearing seven setæ, of the other four, the proximal joint of the former with three stout spines; the maxillæ nearly like *Diaptomus*; the processes have respectively the following numbers of setæ: the basal plate eight, the small process at base of posterior branchial appendage one, the appendage itself twelve, terminal portion three groups, first containing nine, the second three and the third four or five, the upper of the anterior processes two and the lower three; fifth feet nearly like the others in size; the right in the male having the outer branch but two-jointed by the coalescence of the two outer to form an arcuate and deformed appendage armed at the end with three stout equal spines; corresponding branch of left foot three-jointed; the terminal joint bearing three unequal spines, each of the preceding but one; inner branches similar, three-jointed; terminal joint being short and armed with three short lanceolate setæ and three longer ones, two of which are curved so as to be slightly prehensile; fifth foot of female with both rami three-jointed; inner ramus much smaller; antepenult segment of the outer ramus extending into a large lanceolate process; ova sac long-elipsoidal reaching to nearly the end of caudal setæ.

This species prefers running water or estuaries of streams. Crow river, Meeker county, and a brook between Minneapolis and St. Paul.

NOTE ON CANTHOCAMPUS.

Claus says (*Freilebenden Copepoden*, p 121) that he could not find the coiled "shell gland" in Canthocampus, though it is described by Leydig. I have found it in a European species, (*C. minutus?*) and think it constant. Canthocampus also has a singular area of nervous hairs upon the forehead, and in the same situation, pits which seem rudimentary eye-spots and sometimes appear to be pigmented. The pentagonal area mentioned is bounded by a raised line.

CYCLOPIDÆ

Contains five genera, viz.: *Thorellia*, *Cyclops*, *Oithona*, *Lophophorus* and *Cyclopina*; passing, by the genera *Misophria* and *Pseudocyclops*, into the *Calanidæ* or marine copepods. The affinities of these little studied genera need further study, as they are very interesting, the question being still open in how far the cyclopoid forms are altered by adaptation to saline habitat, if such an adaptation takes place at all.

The following is Brady's definition:

Cephalothorax ovate and usually much more robust than the abdomen; anterior antennæ seldom longer than the cephalothorax, those of the male alike on both sides and modified for the purpose of clasping: posterior antennæ branched (i. e. palpus wanting); palps of mandibles and maxillæ usually well-developed: foot-jaws mostly less developed than in *Calanidæ*: first four pairs of feet as in *Calanidæ*, fifth pair rudimentary, alike in both sexes, and usually one-jointed; ovisacs two.

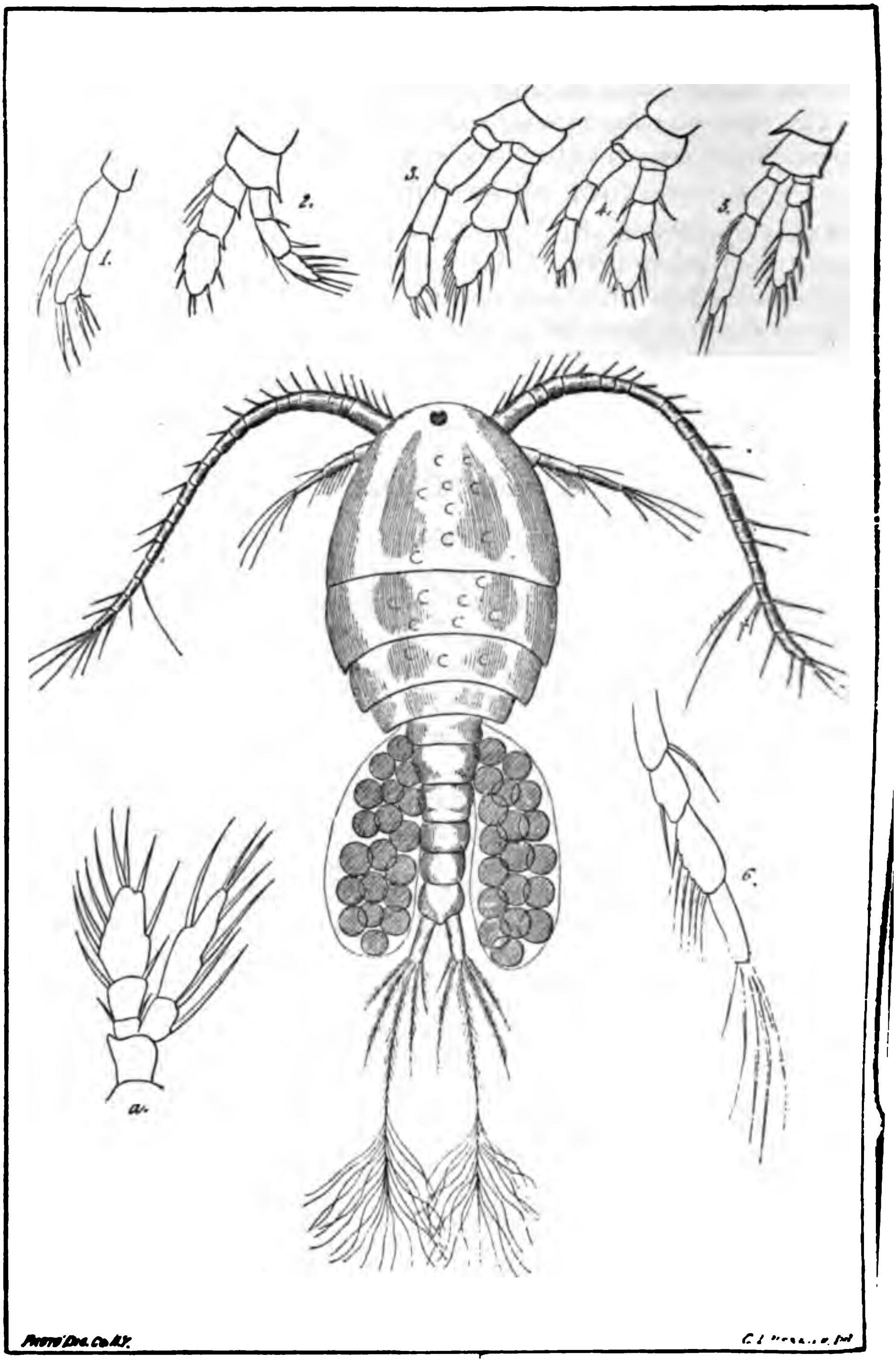

Fig. 2.

A Cyclops with abnormally pectinated caudal setæ.

Genus CYCLOPS.

Brady well says of this genus: "As regards discrimination of species it is, perhaps, the most difficult and puzzling of all the Copepoda." He also states that "the only safe rule in this state of things is to accept no specimens as types which do not show amongst them ova-bearing females." It is necessary, however, to limit the matter more closely, as will be shown farther on, for not only do immature females become fruitful even while the antennæ are yet incompletely developed, but the species are subject to a sort of dimorphism which it is interesting to parallelize with that in the males of *Cambarus*. The species are all fresh-water, so far as it is at present known, though it may be that salt-water forms exist under other names.

The characters of the family with some limitations apply to the genus.

The following species are probably but few of those which occur even in Minnesota, but they are so clearly defined, for the most part, as to be unmistakable and their description it is hoped will form a foundation upon which to lay later study.—Observations extend over a term of about four years.

Species with seventeen-jointed Antennæ.

CYCLOPS TENUICORNIS, Claus.

Bibliography.

Plate VI, figs. 1-11, 20. Plate V, fig. 14.

Cyclops tenuicornis, *Claus*, Das Genus Cyclops.
Die Frei-lebenden Copepoden.
Sars, Oversigt af de Indenlandske.
Ferskvands Copepoder.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
Cyclops signatus, *Koch*, Deutschlands Crust.
G. O. Sars. Uljanin. Brady.
Cyclops coronatus, *Claus. Fric.*

We feel confident that the two forms distinguished by Claus as C. *coronatus* (= *signatus*) and *C. tenuicornis* should be united, as the only distinction which is at all reliable, is the knife-like serrated ridge on the last joint of the antennæ. The last joints are frequently longer in *tenuicornis* form, as are the stylets in *coronatus*, but this varies. In the same gathering (for in so far as we have observed they occur together where circumstances permit a full development,) the *coronatus*-form is larger and carries more numerous eggs. No young with the serrated antennæ have been seen, though searched for diligently. On the other hand young forms of *tenuicornis* abound, and we have seen females with incompletely grown antennæ with egg-sacs. In view of these and similar facts, we feel justified in considering *coronatus* probably a post-imago of *tenuicornis*.

Cephalothorax broad; abdomen rather slender; antennæ reaching about to base of throax, attenuated at the end; terminal joint with a knife-like ridge; formula — ⌣ ⌣ — ⏓ ⌣ — ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ — — —; fifth foot composed of a long basal joint bearing a long spine and a terminal three-spined division; caudal stylets over twice as long as last abdominal segment; setæ all nearly terminal, inner one much longer than usual, length $\frac{25}{100}$ cm.

Common in America, England and continental Europe.

CYCLOPS ATER, n. sp.

(Plate III, figs. 9-12.)

Length about $\frac{21}{100}$ cm; antennæ as long as cephalothorax, $\frac{12}{100}$ cm., slender and gradually tapering; formula* -- ⏓ ⌣ — — ⌣ — ⌣ ⌣ ⌣ ⌣ ⏓ ⏓ ⌣ — -- —; terminal joints rather short; the last joint furnished with a knife-like ridge as in *tenuicornis*; second antennæ much as in *tenuicornis*; maxillipeds rather large; fifth foot one-jointed, armed with three subequal spines; abdomen rather short, last segment very short; stylets somewhat elongated; setæ rather short, lateral seta near the end; eggs pale; color deep blue or gray.

This beautiful and very distinct species is found in "Mud Lake" in Hennepin county, with *Cyclops signatus*. The large very dark cephalothorax and shortened abdomen make it conspicuous. The one-jointed fifth foot, shape of the operculum vulvæ in connection with the shortened joints of antennæ and characters of the caudal stylets, make the species sufficiently distinct from any other.

CYCLOPS INGENS, sp. nov.

(Plate IV, figs. 1-8.)

A large species perhaps too near *C. gigas*, or *C. brevicornis* Claus, but differing from the former as to the length of antennæ and stylets and in not having the distal margins spined (except in some cases?) and from the latter in size and arrangement of caudal setæ.

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*NOTE The accent marks are used to signify that joints represented by them (counting from base) are either long —, short ⌣, medium ⏓.

Thorax large; abdomen rather slender; stylets rather slender with the lateral seta well towards the end; second and third setæ alone long, weakly pectinate; last joint but one of abdomen sometimes toothed along the distal, under margin; maxillipeds as in *C. gigas;* jaws with large teeth; antennæ very short not reaching to the base of the first cephalothoracic segment; formula — = ⌣ — = ⌣ — ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ = =; fifth foot two-jointed, the proximal joint very broad with a strong spine, second joint cylindrical with a long seta and a very short spine near the end; operculum vulvæ somewhat heart-shaped; egg sacs oval-elongated, reaching beyond the end of abdomen; length $\frac{40}{100}$ cm. including stylets and setæ.

This is one of the largest and finest as well as rarest of our forms and loves, as it appears, lakes having outlets.

Small forms with seventeen-jointed Antennæ.

CYCLOPS NAVUS, sp. nov

(Plate V, figs. 6-13-15-17.)

Closely related to *Cyclops pulchellus*, Koch, and to *Cyclops strenuus*, Fischer.

Rather slender; abdomen long; stylets about three times as long as last segment of abdomen; lateral seta rather stout; outer and inner terminal setæ minute; middle ones of moderate length; antennæ short, reaching barely to or but little beyond the end of first segment; formula — = ⌣ — = ⌣ — ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ ⌣ = = =; fifth feet two-jointed, terminal joint large, with two considerable spines; operculum vulvæ of peculiar shape; length $\frac{11}{100}$ cm. excluding setæ.

Quite abundant and perhaps passing into the following.

CYCLOPS PARCUS, sp. nov.

(Plate VI, figs 12-15.)

Almost exactly like the last but not yet found in the same waters. Distinguished by the broad and short basal joint of the fifth foot which extends into a process carrying a spine, the slender second joint with a single long spine and a short thorn, and by the oval shape of the operculum vulvæ.

The caudal setæ are naked for about a third of their length. These distinctions seem constant.

Section with twelve-jointed Antennæ.

CYCLOPS SERRULATUS, Fischer.

(Plate V, figs. 1-5, Plate VII, fig. 10.)

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Lilljeborg, De crust ex ord. trib.
Claus, Das genus Cyclops.
Sars, Oversigt Ferskvands Copepoder.
Frei-lebenden Copepoden.
Fric, Die Krusten thiere Böhmens.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
? Cyclops minutus, *Claus*, loc. cit. (young.)
? Cyclops macrurus, *Sars*, loc. cit.
? Cyclops spinulosus, *Claus*, loc. cit.

Typical Form.

Cephalothorax oval, compact; abdomen slender and short, suddenly enlarged previous to its union with the thorax; antennæ slender, reaching nearly, but not quite to the last thoracic segment; the last three joints are attenuated and furnish the most evident character of the species; formula — ⏓ ⏑ — ⏑ ⏑ ⏓ — ⏑ — — —; during life the antennæ tend to assume the form of a rude Z, the proximal four joints forming the base; antennules small, reaching about to the sixth joint of antennæ; jaws small with large teeth; the single segment of the fifth foot with three equal spines; egg sacs oval, as long as the abdomen; eggs few, dark; caudal stylets very long and slender, spined along the outer margin; lateral setæ small and approximated to the upper one; outer terminal seta short, spine-like, in life set nearly at right angles to the others, spined or beaded on one margin and bristled on the other; the next seta is as long as the abdomen, being somewhat exceeded by the following one; inner seta insignificant; upper seta very small; length less than $\frac{1}{10}$ cm.

A larger form occurs with an elongated body and abdomen and with extremely attenuated antennæ and caudal stylets, but it is not a variety induced by alpine habitat as suggested by Brady, occurring as a "post imago" form with the ordinary type. Claus' description of *Cyclops spinulosus* suggests that this form may be the basis of his species though the form of the male antenna is different from any yet seen. *Cyclops minutus*, Claus, is most certainly the young of some Cyclops, as is indicated both by the description and figures in *Die Freilebenden Copepoden.* Though placed among the twelve-jointed forms the antennæ are eleven-jointed. The fact that the females may have had egg sacs is no proof of their maturity as I have seen undoubted larval forms of *serullatus* with the sacs. Moreover *two-jointed branches of swimming* feet is a larval character. This is a cosmopolitan and very abundant species, occurring in almost all pools and lakes about Minneapolis. The form and structure of the stylets, antennæ and feet make it an easily recognized species.

CYCLOPS FLUVIATILIS, sp. nov.

(Plate VII, figs. 1-9.)

A very small and distinct species of the section with 12-jointed antennæ was found in an estuary of the Mississippi river, (also later in L. Minnetonka) with the following characters:—

Body elongated; thorax very long; abdomen slender; stylets about as long or longer than last abdominal segment; setæ all very short, not pectinate; lateral and dorsal setæ very small; outer one spine-like, short and stout, two middle short, inner one very small and inconspicuous; antennæ reaching nearly to the base of abdomen; formula, — ⏓ ◡ — ∸ — — — — — — —; the three joints following the six basal are much elongated while the terminal ones are but moderately so, a character which is peculiar to this species; terminal segment slightly but evidently hinged, and together with pair preceding somewhat curved; feet with the terminal spines strongly toothed; fifth foot very small, one-jointed, bearing three small setæ; operculum vulvæ heart-shaped; egg sacs subquadrangular; eggs large; abdomen in the young much elongated; color deep indigo, length $\frac{7}{100}$ cm.

CYCLOPS ADOLESCENS, sp. nov.

(Plate VI, figs. 16-20.)

The form figured under the above name seems closely allied to *C. affinis*, Sars, from which it differs chiefly in the arrangement of the joints of antennæ.

The body passes without marked transition into the abdomen which is abnormally shortened; caudal stylets very short as is the last segment of the abdomen; setæ exactly as in *C. parcus* with which it was found; antennæ eleven-jointed; formula — ⏑ — ⏑ ⏑ ⏓ ⏓ ⏑ ⏓ —; a semi-circular series of spines upon the basal joint; fifth foot obsolescent, the three spines appearing to spring directly from the last thoracic segment which also bears a series of teeth; egg-sac reaching to base of abdomen, with rather numerous eggs; feet heavily spined on one margin; length $\frac{11}{100}$ cm., male $\frac{9}{100}$ cm.

This species, together with all others of this sort with eleven-jointed antennæ, is perhaps but an immature and abnormally modified form of some of the common species If this be true the rarity of these nominal species is explained. *C. minutus*, Claus, is certainly but a larval form, as is shown by the two-jointed branches of swimming feet.

Section with 8-jointed Antennæ.

CYCLOPS CRASSICORNIS, Müller.

(Plate IV, figs. 9-14.)

Bibliography.

Cyclops crassicornis, *Muller,* Entomostraca.
Sars, Oversigt Ferskvands Copepoder.
Uljanin, Reise in Turkestan.
Brady, British Copepoda.
pauper, *Fric,* Die Krustenthiere Böhemens.
? magniceps, *Lilljeborg,* De crustaceis ex ordinibus tribus, etc.

A small species characterized by its small size and the eight-jointed antennæ; body depressed and passing gradually into the rather uniform abdomen; first cephalothoracic joint large; abdomen rather slender; stylets of moderate length, spined along the outer margin somewhat as in *C. serrulatus*; outer seta lance-shaped, short; the next one as long as stylets and last two segments; the following one nearly twice as long; inner one very small; last joint of abdomen spined; the preceding one fringed on distal margin with weak setæ; antennæ short, not reaching the base of first segment; formula — — ⏓ — ⏑ ⏑ ⏑ ⏓; the basal joint with a semi-circular set of fine bristles, and with the following is furnished with pectinate setæ; second antennæ short; terminal joint short, with two curved, strong spines and other weaker ones; fifth feet small one-jointed with three unequal spines, bordered above by a spined plate of the last thoracic segment; length about $\frac{11}{100}$ cm. excluding setæ.

This species appears not to be very abundant, or at least from its small size it is not often encountered. A few particulars distinguish these western forms from the description given by Brady, among them being the spinous armature of the stylets, the bristles on the penultinate segment of the abdomen, pectinate bristles of the fifth feet, and the greater length of the abdomen, yet I see no reason for separating them. I have not seen the male and can not be sure that there is no further development, but the fact that the feet in this form are three-jointed, and its peculiar characters, clearly distinguish the species from any other known to me.

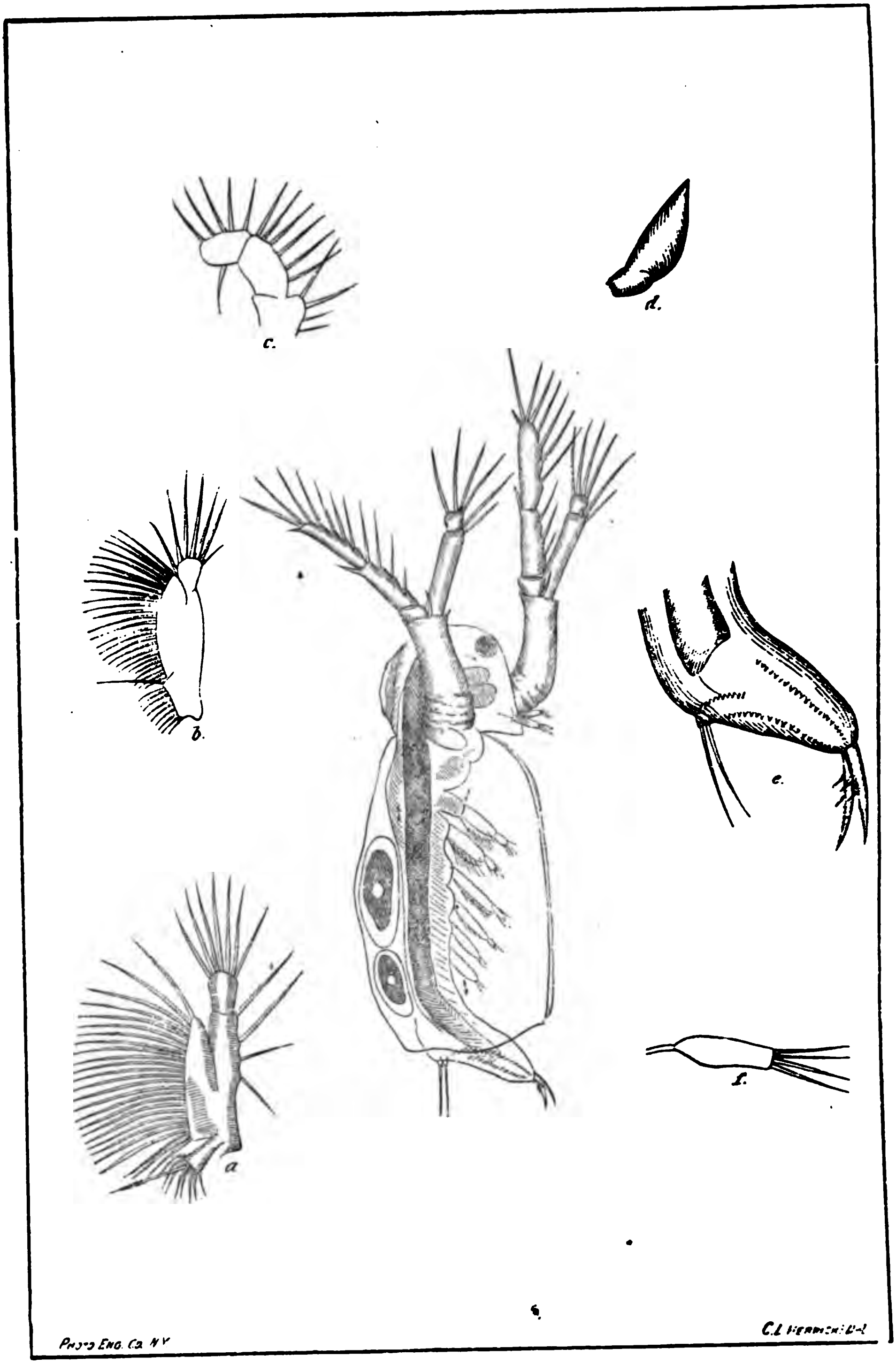

Photo Eng. Co. N.Y.

C. L. Herrick Del.

Fig. 3. *Sida crystallina.*

II. Notes on some Minnesota Cladocera.

Tribe I Ctenopoda.

SIDIDÆ.

Antennæ of second pair with unequal rami, superior larger; last joints compressed and setose; intestine simple.

Of this family two species are certainly identified in America, both of which are abundant in certain favorable locations at the proper seasons. No species of the *Holopedidæ* are known to occur here.

Genus Sida Straus.

Superior ramus of second antennæ three-jointed; posterior margin of post-abdomen with numerous spines (20-30.)

Sida crystallina, Müller.

(Fig. 3.)

Bibliography.

Daphne crystallina, *Müller*.
Daphnia crystallina, *Latreille*. *Bosc.*
Sida crystallina, *Straus*, Mèm. Mus. Hist. Nat.
Sida crystallina, *M. Edwards*, Hist. Nat. Crust.
Monoculus crystallinus, *Gmelin*. *Manuel*. *Fabricius*.
Monoculus elongatus *De Geer*, Mèm. servir Hist. Ins.
Sida crystallina, *Lievin*, Branch. d. Danziger Geg.
Baird, Brit. Entom.
Lilljeborg, De crust. ex ord. trib.
Fischer.
Schödler, Die Branch. d. Umg. v Berlin.
Neue. Beitr.
Leydig, Naturg. d. Daph.
Sars, Norges Ferskv—Krebsdyr.
elongata *Sars* " " "
Sida crystallina, *P. E. Müller*, Danmark's Cladocera.
Kurz, Dodekas Neuer Cladoceren.
Birge, Notes on Cladocera.
Herrick, Microsc. Entom.
Lutz, Untersuch, ü. d. Cladoceren d. Umg. v. Bern. 1878.
Weismann.

I note this cosmopolitan species, of which a nearly complete bibliography is given above, simply to mention that I have recently found for the first time specimens of *Sida* reaching the size mentioned by P. E. Müller ($\frac{30}{100}$ cm.)

In smaller pools, when present our *Sida* is much (often $\frac{1}{3}$) smaller, and only in L. Minnetonka does the species attain its ultimate development.

Genus DAPHNELLA.

Superior ramus of second antennæ apparently 2-jointed, narrow; post-abdomen destitute of spines.

DAPHNELLA BRACHYURA Lievin.

(Plate VII, 11-16)

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Daphnella wingii, *Baird*, Brit. Entom
Sida brachyura, *Lilljeborg*, De crust. ex ord. trib.
Diaphanosoma brandtianum, *Fischer*, Ergänzig. Berichtig.
Daphnella brandtiana, *Sars*, Norges Ferskv.—Krebsdyr.
Daphnella brachyura, *P. E. Müller*, Danmark's Cladocera.
Daphnella brachyura, *Lutz*. Untersuchung ü. die Cladoceren d. Umg. v. Bern.
Sida brachyura, *Pavesi*, Nuova serie di recerche della fauna pelagica nei laghi italiani, (L. Trasimens.)

(Compare also *D. expinosa*, Birge, Notes on Cladocera p. 3.)

The species of *Daphnella* found about Minneapolis, occasionally abundant, seems not to differ in any important character from European types of *D. brachyura* although I formerly regarded it as distinct (*D. winchelli.*)

Head less than one-half the body (about $\frac{27}{1000}$ cm. while body is $\frac{6}{1000}$ cm. long); eye about $\frac{1}{4}$ head; antennæ when reflexed extend a little beyond $\frac{2}{3}$ the length of body. Male $\frac{7}{100}$ cm. long; antennæ reflexed reaching base of shell; anterior antennæ extremely long; copulating organs reaching nearly to end of claws. Having carefully compared our specimens with the description and figures given by Birge for his *D. expinosa*, the evidence seems to indicate not only that they are identical but both are really *D. barchyura*. The distinctive characters of *D. expinosa* are a greater indentation between head and body, absence of caudal teeth, greater length of male appendages, and the opening of the vasa deferentia in the "instep" of these appendages.

The absence of teeth upon the post-abdomen is of even generic importance according to Sars, who gives it in his synopsis of genera as typical for *Daphnella*. In our specimens the claws are at least pectinate if not serrate, while the appendages of the male reach generally nearly to the middle of the claws. The relative length of these appendages and the antennæ of male is variable.

Tribe II, ANOMOPODA.

DAPHNIDÆ.

Rami of antennæ 3 and 4-jointed; feet of five pairs; intestine with anterior cœca not convolute.

Genus MOINA, Baird.

A transition between *Sididæ* and *Daphnidæ* is made through this genus.

Head separated from the body by a depression; macula nigra absent; antennæ of female large, movable, of male very long, curved; first foot of male with strong hook; valves short, truncate behind.

MOINA BRACHIATA.

We believe with P. E. Müller that this and *M. rectirostris* are identical. The most complete discussion of the merits of the three species (the above and M. paradoxa) is found in Weismann's paper, *Ueber einige neue oder unvollkommen gekannte Daphniden*, Grüber and Weismann, 1877, which see for bibliography and elaborate, not to say labored, distinctions. This species is not common, but when found (in muddy pools in late summer) frequently appears in great numbers. For embryology see *Grobben*, Entwicklungsgeschichte der Moina rectirostris.

Genus DAPHNIA.

This genus as limited by Müller is well distinguished from the remaining genera of the family--*Simocephalus, Scapholeberis, Ceriodaphnia* and *Moina*.

As remarked by Birge, this is not the typical representative of the group but is a very divergent member of it, worthy, probably, of forming a distinct section or sub-family. The most remarkable feature is one which appears in a comparatively early embryonic period and, in some cases, nearly disappears in later life This is the development of a long spine from the dorsal, posterior end of the shell. This is the real diagnostic test and has not yet been incorporated into the definition of the genus The occurrence of a crista is more variable apparently, but may be of some importance.

The following is suggested as a revision of the diagnosis:

Shell more or less oval or sub-quadrate and reticulate; head rounded anteriorly, but sometimes with a crest, prolonged below into a beak which is truncate posteriorly and bears the antennæ near the apex; upper dorsal corner of shell in young of both sexes and mature males prolonged into a long spine; the macula nigra is present but not always pigmented; the post-abdomen spined behind; opening of rectum at the end.

The female with two age-forms (heterogenetic and dimorphic); the second form frequently scarcely spined; antennæ small, not movable, furnished with sense-hairs; ephippium with two ova, separable from remainder of shell along the latero-median suture; the brood-cavity closed by more than two unequal processes of the abdomen.

Male with long movable (almost two-jointed) antennæ furnished with prehensile stylus; first foot bearing a curved claw; swimming antennæ very long; vas deferens opening at the end of post-abdomen. Embryo with second antennæ palpate; a curved appendage to shell which becomes the spine of adult.

DAPHNIA PULEX.

This species is mentioned here simply to remark concerning *D. pulex*, var *denticulata* of Birge, (Notes on Cladocera, p. 11, plate I, fig. 11,) that the European as well as all the American specimens of *D. pulex*, have a fine series of spines on the claws of the post-abdomen. A glance at Tafel XII, fig. 39, of the Zeitschrift für Wiss. Zoöl. Bd· XXXIII, with Weismann's plate of the end of the abdomen of this species, is sufficient evidence of this fact, though as the animal is a male and quite young, the spines are less evident; moreover the number of caudal teeth is known to be variable with age. Some other peculiarity must be found to give this varietal distinction validity.

DAPHNIA sp?

(Plate X, figs. 15-16).

From a cold marsh a gathering in June, 1882, contained several females like that represented by fig. 16. They were far from being abundant, however, and the pool contained no other Daphnia showing that it was unfavorable to the growth of these animals.

These females differ from *D. pulex* chiefly in their small size, ($\frac{14}{100}$ cm.) being the smallest Daphnia seen with an evidently mature appearance. The caudal spine is sickle-shaped; post-abdomen as in *pulex*; antennæ short; the animal beautifully clear and varigated by the brilliant contents of ovary, eggs and intestine. I hesitate to regard it as a destinct species.

Figure 15 represents a single specimen of Daphnia found with the above which was somewhat injured during its moult. This resembles *D. apicata*, Kurz, and *D. pellucida*, Müller, and is perhaps the male of the species represented by fig. 16. Our knowledge of the variations induced by environment is yet too meager to draw up definitions of species with certainty from a single gathering, but these forms are peculiarly interesting.

See also the accompanying figure, (fig. 4,). These forms merit closer study.

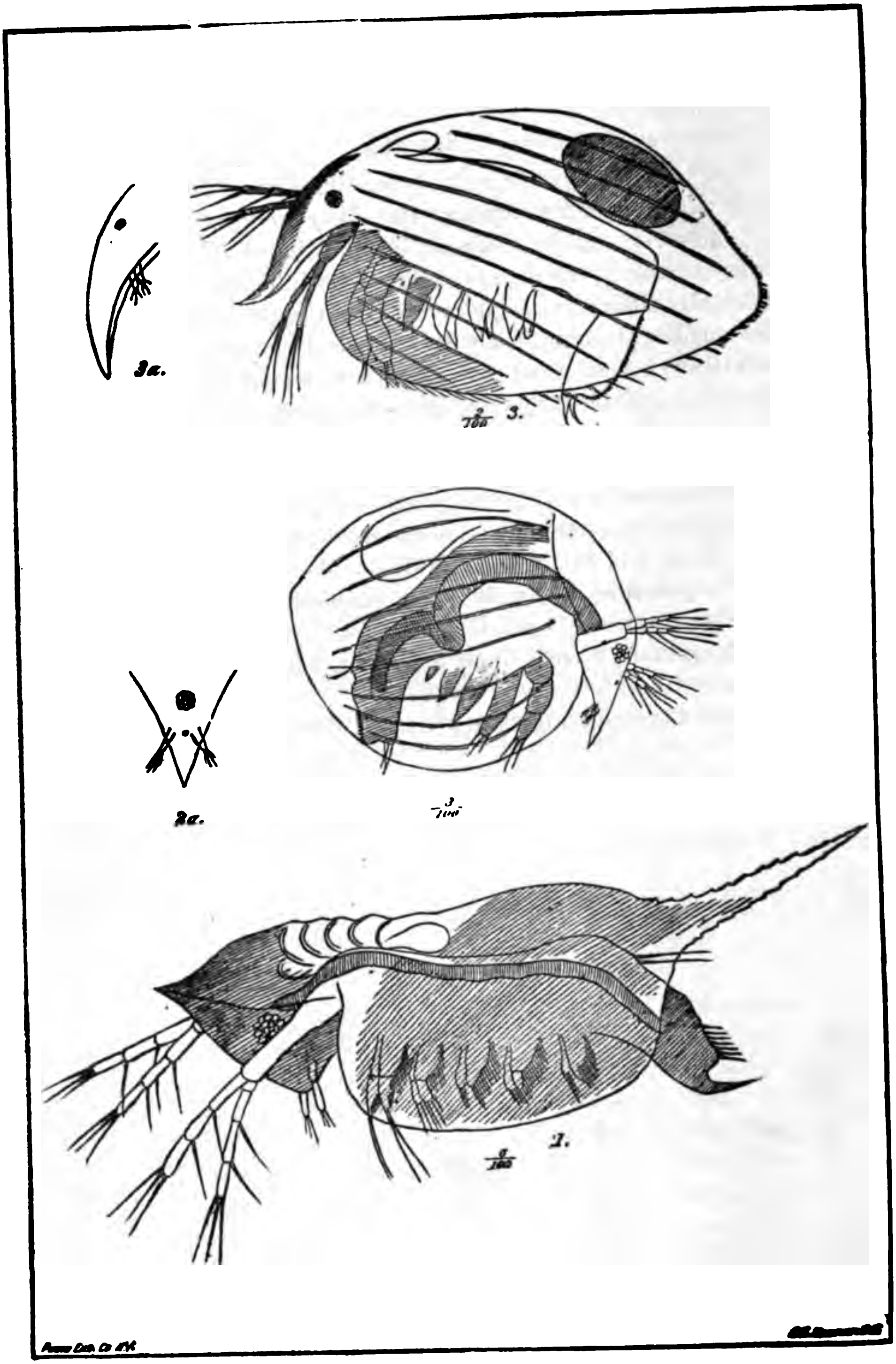


Fig. 4. Daphnia longispina (numbered 1) etc.

SCAPHOLEBERIS, Schödler.

In a former paper *S. mucronata* was reported from this locality with the remark that only the unhorned variety seems to occur here. A rather diligent search has failed to find var. *fronte cornuto,* though our waters have been carefully searched at intervals for several years and at different seasons Birge quotes only this variety. However, the species is not common and the other form may yet be discovered. See Fig. 5.

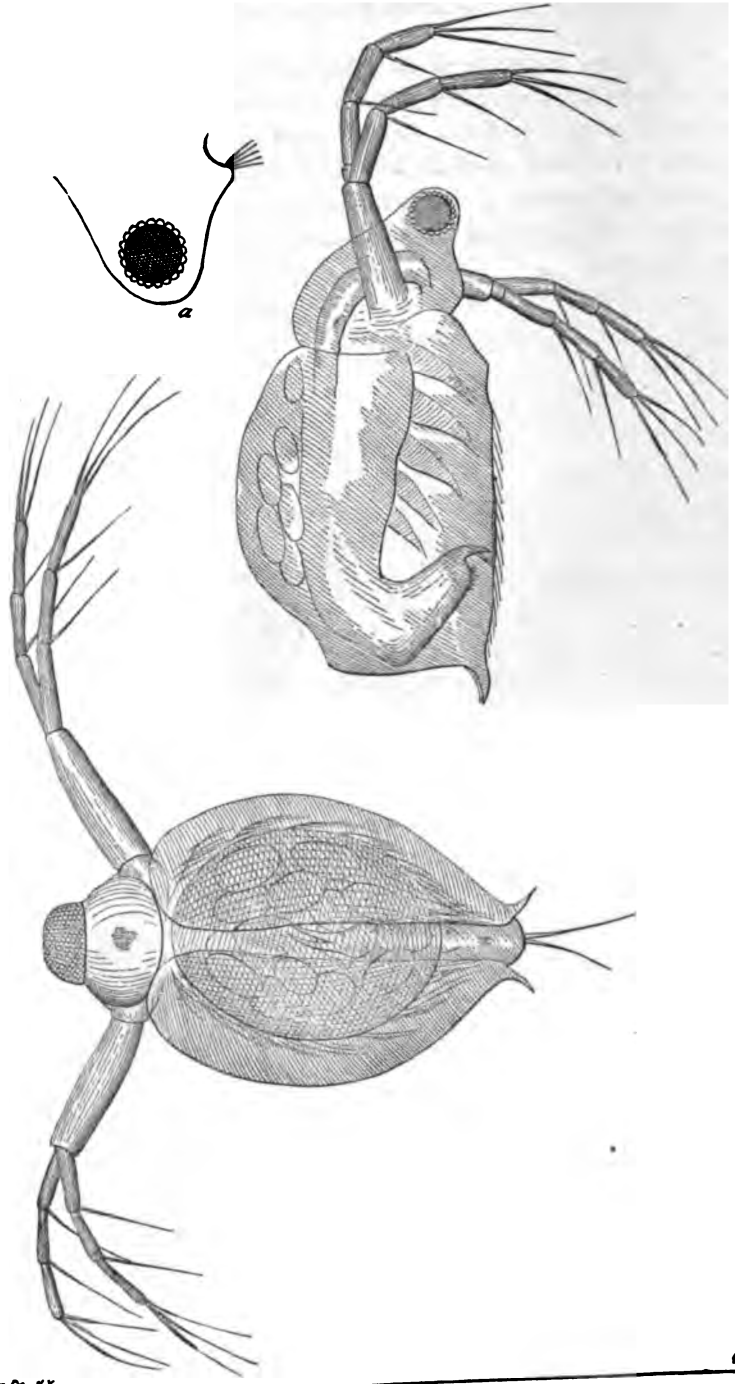


Photo Eng. Co. N.Y.

C. L. [illegible] del.

Fig. 5. [illegible] Scapholeberis mucronata.

A second variety or species has been found which differs somewhat from typical *mucronata*, but does not appear to be *nasuta* of Birge. Is not the latter a variety simply?

SCAPHOLEBERIS ARMATA var.? nov.

Length $\frac{7}{100}$ - $\frac{8}{100}$ cm.; much as *S. mucronata* in form; but the spines are greatly elongated in old as well as young individuals; and in individuals having winter as well as summer eggs, though the winter form seems to have longer spines which are nearly equal in some cases to the hight. Antennæ are short and transparent. The head is separated from the body by a marked depression; but is curved forward so that the beak lies generally between the valves. The antennules are of medium size. Nowhere reticulate (?) nor tuberculate. The shell is marked by impressed lines, especially anteriorly and below. The lower margin is straight and beaded anteriorly, but toward the base of the *mucro* are several long bristles which stop abruptly and are followed by a few very weak hairs. The post-abdomen has three teeth at the base of the claws, which are smooth.

This variety is much like *S. nasuta* of Birge, perhaps, but differs perceptably in several points. Most conspicuous are the greatly elongated spines and the short antennæ. This variety is about as large as *mucronata* but less than *nasuta*.

BOSMINIDÆ.

Genus BOSMINA.

First antennæ many-jointed; intestine straight. Sole genus of the family, and one which Kurz characterizes as "one of the most difficult of the genera of Cladocera."

There are three species known in the United States, two of which are found from the Eastern States to the Mississippi and westward, and are identical with European forms. The third may not prove distinct.

BOSMINA LONGIROSTRIS.

(Plate X, fig. 2.)

Differs from the following in having the terminal claws not toothed, and from *B. striata* in the shorter antennæ and reticulate shell.

BOSMINA CORNUTA.

(Plate IX, figs. 3–5.)

$\frac{35}{000}$ cm. long; shell reticulate with hexagonal meshes; antennæ curved backward and outward at the tip; claws with several teeth near the base. In embryonic specimens the antennæ are straight.

BOSMINA STRIATA, sp. n.

(Plate IX, fig. 1).

$\frac{25}{1000}$ cm. long; shell marked with anastomosing longitudinal striæ; antennæ very long; frontal seta about midway between eye and the sense-hairs of the antennæ: posterior inferior angle of shell spined as in the previous species.

The species resembles *B. maritima* greatly. The members of this genus have been little studied owing to their small size and comparative rarity, and it is even possible that some of the species will prove invalid.

All three of the above species were found in one gathering from Lake Minnetonka. Only one other locality (for *B. longirostris*) is known to me in this State.

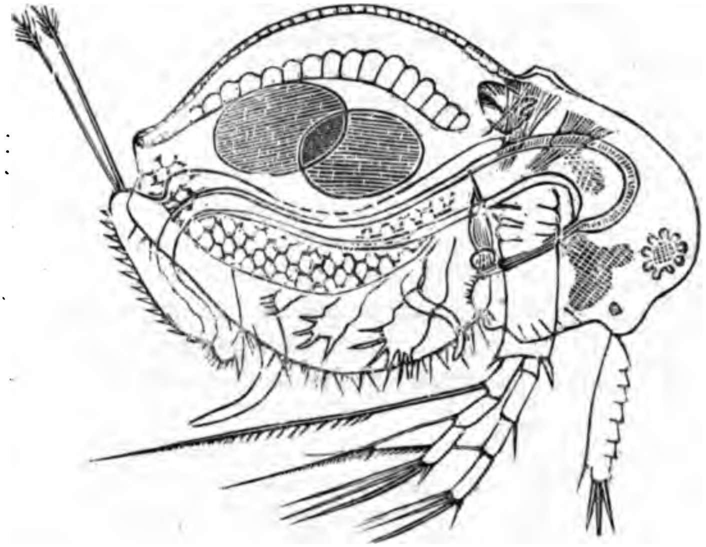
LYNCODAPHNIDÆ.

Genus MACROTHRIX.

Aside from *M. roseus* and *M. tenuicornis* (to which, perhaps, *M. agilis* of a previous report may be referred) a single species of macrothroid crustacean was collected at Lake Minnetonka, which is very remarkable. The specimen was apparently somewhat injured in moulting, and it is not possible to tell how much of its peculiar shape may be due to this fact, but some of its characters are sufficient evidence that it constitutes at least a new species.

It resembles in outline *Simocephalus vetulus*; the antennæ are very narrow and curved in a lateral as well as posterior direction; the second or swimming-antennæ are long as in other members of the genus; *macula nigra* present but small; eye small; post-abdomen short, triangular; claws pectinate; a dorsal sucking-disc is present;

length $\frac{10}{100}$ cm. For this species the name MACROTHRIX PAUPER is provisionally offered. (Plate VIII, fig. 1.)



(FIG. 6.)

MACROTHRIX TENUICORNIS, Kurz.

(FIG. 6.)

The description given by Kurz is very full and agrees very well. The peculiar arrangement of the movable spines at the margin of the valves is characteristic. I have observed that *this species forms an ephippium.* Müller says destinctly of the series of genera including *Macrothrix, Drepanothrix, Lathonura, Bosmina, Acantholebris and Iliocryptus,* "*Testae abjectæ corporis, nullo ephippio, ova hiberna obtegunt.*"

Bosmina is little related to the *Lyncodaphnidæ* and, however it may be with regard to other species, in *M. tenuicornis* an evident ephippium is formed in much the same way as in *Ceriodaphnia.* In *Daphnia* this egg-cover is produced by an alteration of part of the inner layer of the shell which becomes turgid and secretes a thick coating. The ephippium simply extends over the brood-cavity, being marked off from the rest of the shell by the median suture of the valves. In other *Daphnidæ* and in *Macrothrix* nearly the whole of the valves are thus modified. The shell of *M. tenuicornis* is normally smooth, but in the ephippial female, that portion of the inner layer of the shell bordering the egg-cavity and a little beyond, is composed of large and very deep cells; the space between the outer and inner layers is much greater than in *Daphnia*.

Genus LATHONURA.

Although no species of this genus has been found in Minnesota, it is to be expected that it will eventually be discovered that the cosmopolite *L. rectirostris*, Müll. occurs in our limits. It occurs in Mass. according to Birge. The figures (Plate VIII, figs. 11-12) were drawn from specimens found in Leipzig, Saxony, illustrating a tendency, especially common in the *Lyncodaphindæ*, to abnormal growth of the spinous appendages—in this case the anal setæ.

Genus ILIOCRYPTUS.

A genus represented by a single European species. Our form may differ somewhat in some respects from the generic diagnosis, but certainly belongs here. There are no anterior cœca (as indeed there are probably not in the European *I. sordidus* though so stated by Müller,) and no permanent cœcum or dilation of the intestine before the rectum. The marginal spines are straight, long and movable without branches.

ILIOCRYPTUS SPINIFER sp. nov.

(Plate VIII, figs. 2–6.)

Short; depth nearly equaling length of body excluding head; rounded behind; free edges of valves beset with slender ciliate spines which are not branched; antennæ exactly as those of *I. sordidus*, as is the post-abdomen, save that the anus seems to be situated higher; ova three or more.

This species occurs in Silver lake, east of Minneapolis. It swims quite well, while of the European species it is said this is not the case. It does, however, frequently load itself with filth so as to be too heavy to swim freely.

LYNCODAPHNIA, Gen. n.

(Plate IX, figs. 1-3.)

Form much as is species of *Alonella*, etc., truncate behind; superior antennæ like *Macrothrix*, attached movably to the end of a blunt prominence beneath the head; second or swimming antennæ slender; four-jointed ramus with three long setæ at the end of terminal joint where is also a stout spine; joint following the basal joint also with a spine above; middle joint unarmed (?); three-jointed ramus as in *Macrothrix*; the basal segment armed with a much elongated seta; eye relatively small; pigment fleck present; *intestine twice-convoluted*, expanded in front of colon, opening in the "heel" of the post-abdomen; post-abdomen slender, sub-triangular, margined behind with a double series of spines; terminal claws large, straightish and furnished with a long and short spine near the base, also very minutely feathered behind; shell marked alone by the so-called "stuzbalkein;" lower margin with movable spines.

Few more interesting forms have been noticed than this, since it combines the characters which have hitherto been considered as very clearly forming the boundaries of distinct families.

Kurz says, (*Dodekas neuer Cladoceren nebst einer kurzen Uebersicht der Cladocerenfauna Böhmens*, p. 30:) "Keine Cladocerenfamilie bildet eine so streng in sich abgegrenztes natürliches ganze, wie eben die Lynceiden," and this even after recognizing the relationship of *Macrothrix* and *Lathonura* to the Lynceids by placing them in the sub-family *Lyncodaphniæ*. The form for which I propose the name *Lyncodaphnia* is quite as much like such forms as *Alona* and related Lynceids, as any species of the *Lyncodaphninæ*, while at the same time the characters of antennæ and head are almost identical with *Macrothrix*. This furnishes but another example of the fact that possibility of distinguishing families and genera lies alone in the meagerness of our knowledge.

LYNCODAPHNIA MACROTHROIDES, sp. n.

Form sub-rectangular, greatly elongated; length $\frac{12}{100}$ cm., hight $\frac{5}{100}$ cm. or less; first antennæ long and slightly curved, bordered behind by about ten spines and terminating in two unequal sword-shaped spines and several sense-hairs, about $\frac{17}{1000}$ cm. long; swimming antennæ very slender as in *Macrothrix*, $\frac{6}{100}$ cm. long; head not marked off by a depression from the body, small and extending below into a blunt elevation for attachment of antennæ; labrum rather large; eye small; macula nigra conspicuous but not large; anterior feet strongly armed with curved spines. The intestine anteriorly is furnished with cœca, is twice convoluted, broadened before entering the rectum and opens a little distance beyond the oval seta in the heel of the post-abdomen; post-abdomen rather slender, toothed behind with a double series of about twelve prominences, becoming distally sharp, strong teeth; terminal claws curved at the end only, pectinate and bearing two unequal but large processes near the base; eggs much like those of *Macrothrix.*

Occurs in Lake Minnetonka, Hennepin Co., Minnesota, rare.

LYNCEIDÆ.

But few of this large family, furnishing the majority of the Cladocera fauna of any locality and at any time of year, have been carefully studied here. The following are mentioned as of particular interest:

SUB-FAMILY EURYCERCINÆ.

The single species *Eurycercus lamellatus* which constitutes this subfamily has been mentioned and figured in a previous paper. It is quite abundant and constant.

Eurycercus is connected with the true Lynceids by the following genus which has quite as many affinities with *Eurycercus* as any Lynceid. Schödler seems to be the only writer who has laid sufficient stress upon this similarity, though it may not be best to unite the two forms as he did.

Genus LEYDIGIA, Kurz.

LEYDIGIA QUADRANGULARIS, Leydig.

(Plate VIII, 7-8.)

The Minnesota species is referred to *L. quadrangularis* under the belief that there is no specific distinction between that species and *L. acanthoceroides*, Fischer.

Our form does not agree in every particular with the very minute description of Kurz and does agree very well with what is said of *L. acanthocercoides*. However, Kurz says of the latter species, "Diese Art is von der vorangehenden (*L. acanthocercoides*) im weiblichen Geschlecht schwierig zu unterscheiden," and immediately adds that the male is unknown to him. In P. E. Müller's time both males were unknown. Müller says of *acanthocercoides*, "ungues caudales inermes," of *quadrangularis*, "ungues caudales dente minuto." Kurz on the other hand says of the former, "der Basaldorn ist kurz," of the latter "die Endklauen haben keinen Basaldorn."

Our species has no spine on the claws, and has a small spine on an eminence on the dorsal part of the abdomen, as well as two ciliated prominences between it and the oval setæ; length $\frac{9}{10}$ cm.; color red.

Silver Lake, east of Minneapolis.

CAMPTOCERCUS MACROURUS.

(Plate X, fig. 9.)

This large species occurs rather sparingly at Lake Minnetonka. It is probably widely distributed in America as well as Europe. It is known in Cambridge, Mass. and Madison, Wis. (Birge).

CAMPTOCERCUS ROTUNDUS, sp. nov.

(Plate VIII, figs. 9–10.)

Short, quadrangular, dorsally nearly uniformly arched; antennæ of first pair long, curved outward, with long terminal bristles; abdomen long, nearly uniform in width; teeth of post-abdomen few, inconspicuous; terminal claw nearly straight; basal spine large; the claw also has a series of spines beginning a little beyond the middle and shortening proximally; length $\frac{7}{100}$ cm. This resembles *C. rectirostris*, Schödler, a little in outline of body but the head is like *C. macrourus*, except that there is a slight beak directed anteriorly (not shown in the figure); the post-abdomen is much as in *C. macrourus*, but is less heavily spined. In size it is somewhat less than *C. lilljeborgii*, and the shortest species known to me.

ACROPERUS sp?

(Plate X, fig. 10.)

Resembles *Camptocercus macrourus* greatly. Are these two genera really distinct?

PLEUROXIS PROCURVUS, Birge.

(Plate X, fig. 6)

Very characteristic. Found in Shady Oak lake, and elsewhere abundant.

PLEUROXIS UNIDENS, Birge.

A species which agrees best with this is quite abundant. It is, however, always of a deep brownish color, and the beak is long and curved inward; it may be distinct.

A third form of *Pleuroxis*, probably *P. denticulatus*, Birge, is abundant also.

GRAPTOLEBRIS INERMIS, Birge.

(Plate X, figs. 8, 11–12.)

Resembles *Alona testudinaria* very closely; the antennæ are peculiar; each joint has a median circlet of fine bristles; the upper ramus is terminated by two long setæ, one shorter seta and a stout spine; the joint preceding the terminal one has a stout seta. The description given by Birge is otherwise complete. Lake Minnetonka.

CREPIDOCERCUS SETIGER, Birge.

This is exceedingly rare, and by reason of its small size, difficult to distinguish. It has been encountered but once in Minnesota. This species is easily recognized when found, and though our specimens differ a little from the figure given by Birge, they are doubtless the same.

ALONA OBLONGA, P. E. Müller.

The specimens examined differ somewhat from Müller's description. The caudal claw is pectinate; the spine at its base is large and covered with a tuft of hairs; the teeth of post-abdomen are large, emarginate and hairy; otherwise the agreement is very close; length .07 cm. Found in Grass Lake, Richfield.

TRIBE III ONYCHOPODA.

POLYPHEMIDÆ.

POLYPHEMUS PEDICULUS.

(Plate IX, figs. 4–6.)

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Polyphemus oculus, *Lievin*, Branch. d. Danz.
Polyphemus stagnorum, *Fischer*, Ueber die in d. Umg. von St. Petersburg, vorkom, Crust.
Polyphemus pediculus, *Lilljeborg*, De Crust. ex ord. trib.
Polyphemus oculus, *Leydig*, Naturg. d. Daph.
Polyphemus pediculus, *Schödler*, Neue Beitr. zur Naturg. d. Cladoceren
Polyphemus kochii, " " " "
Polyphemus oculus, " " " "
Polyphemus pediculus, *P. E. Müller*, Danmark's Cladocera.
Kurz, Dodekas neuer Cladoceren.
Weismann, Beitr. z. Naturg, d. Daphnoiden.
Birge, Notes on Cladocera.

I have collected from various sources what I could of the extensive bibliography of this, the sole species of the genus. One of the most characteristic and pleasing figures given is that of Weismann in his article on the "Schmuckfarben der Daphnoiden," though we believe that author in the wrong in the deductions made. Our specimens rarely approach the brilliancy of the plate, and there seems to be a more legitimate way of explaining these secondary colors than by sexual selection. This species is never abundant, nor is it very rare; found in Lake Minnetonka, and the larger lakes with their outlets.

III *On Notadromas and Cambarus.*

CYPRIDÆ.

This group is one of the most difficult and perhaps least studied. A number of species some of which, perhaps most, are new, occur in Minnesota, and among them is a *Cypris* which exceeds any described form in size. I only mention one genus which is cosmopolitan.

NOTADROMAS, Lilljeborg.

Carapace differing in male and female; eyes two; antennæ similar to those of *Cypris*, the superior having seven and the inferior six joints; setæ of inferior antennæ reaching beyond the apex of the terminal claws; second pair of jaws without a branched appendage, in the male pediform; abdominal rami rather long.

NOTADROMAS MONACHUS, Müller.

Bibliography.

Cypris monacha, *Muller, Latreille, Bosc, Demorest, Baird. Edwards.*
Monoculus monachus, *Gmelin, Manuel. Fabricius, Rees, Jurine.*
Notodromas monachus, *Lilljeborg*, De Crust. ex ord. trib.
Brady, British Ostracoda.

Females of this widely distributed species were collected near Minneapolis, presenting in as far as could be seen no material points of distinction from English types.

DECAPODA.

But two species of *Cambarus*, *C. virilis*. Hagen, and *C. signifer*, occur in Hennepin county, except, perhaps, in the Mississippi. The following localities for the former species are known in the State: Mississippi river, Minnehaha creek, Bassett's creek, Cedar lake, Lake Minnetonka, Lake Independence, Lake Superior.

It is possible to recognize three age-forms in the males of this species.

A. The immature male (II Form, Hagen). Reaching two to three inches in length, this stage has the chelæ proportionally smaller, and the spinous armature less developed: the first abdominal foot is simply bifid at the end.

B. (Form I of Hagen,) usually over two and one-half inches long; chelæ larger; branches of abdominal foot destinct; inner branch grooved but lance-linear.

C. Very large (four inches); inner branch of abdominal foot spatulate at end; the two rows of tubercles on the inner margin of the "hand" with six or seven in a row instead of five.

Male of Form II, A stage, 2½ in. long, Chela. 7 in., thumb .49 in.
" " I, B stage, 2½ in. long, " 1 in., " .6 in.
" " I, C stage, 4 in. long, " 1.8 in., " 1.1 in.
" " II, A stage, 3 in. long, " 1.2 in., " .75 in.

It will be seen from the above that size does not govern the transition from the first to the second form entirely. This differs either in different localities or at different seasons of the year. A large gathering from Cedar lake showed no specimens of the form I, while a similar gathering at Lake Independence contained but one of the form II. A male from Minnehaha creek had rudiments of a third tooth on the carpus of the left claw, thus indicating an approach to Hagen's Var. A.

CAMBARUS SIGNIFER sp. nov.

(FIG. 7.)

A slender, graceful species of rather marked colors, belonging to the section having a hook on the third pair of legs but not on the fourth. The rostrum is not carinated nor toothed at the apex; acumen moderate, lateral borders curved, moderately excavated. Cephalothorax arched and not depressed above, densely punctate: areola linear; chelae slender, straight; thumb deeply excavated on the inner margin for the proximal one-third: opposite finger with an impressed groove on the inner but not on the outer margin.

Male, I Form. Color reddish-(crimson) brown, not obviously figured: tail lighter; fin chestnut, marked with gray: chelæ bright crimson below there are green markings on the body and legs, and some yellow below.

The hands are rather narrow and straight, while the "thumb" is deeply excavated for one-third its length, and the notch thus formed is armed with three or four teeth; the finger opposite has a tooth half way from the apex, and others near the base; the ange at base of thumb is densely hairy. The penultimate and previous joint of second foot bears a very dense and thick tuft of hairs on the inner margin which it particularly noticeable in living specimens. The antennæ are short about as long as the thorax when reflexed.

The first pair of abdominal feet resemble those of *C. virilis* somewhat, but are stouter and less divided. They are more strongly curved than in *C. propinquus.*

The laminæ of antennæ are much as in *C. troglodyles* but wider at the base.

The second form has the two branches of the abdominal foot united almost to the end. The young males have the chelæ greenish-blue and mottled, while the coloration of the body is like the females.

The females have shorter chelæ, and broader abdomen marked with chestnut bars on each segment above.

A male 3.3 in. long was still in form II, while another 3.2 in. long was in the form I. Found by hundreds in a shallow pool known as Grass Lake, in Richfield, Hen. Co.

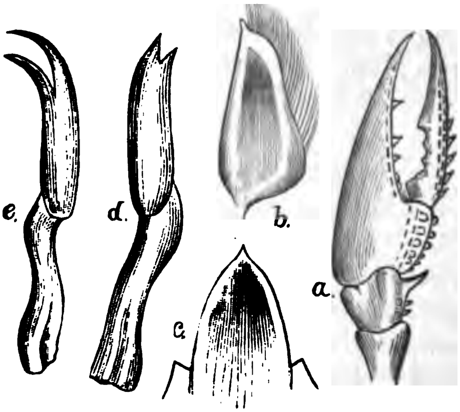

Fig. 7.
Cambarus signifer.

a chela. *b* lamina of antenna. *c* rostrum. *d* abdominal foot of *form* II. *e* abdominal foot of form I.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

The First Annual Report of the Geological and Natural History Survey of Minnesota, for the year 1872. 8vo. 112 pp , with a colored geological map of the State. *By N. H. Winchell.* Published in the Regents' Report for 1872. Out of print.

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. *By N. H. Winchell and S. F. Peckham.* Regents' Report; 148 pp. 8vo., with illustrations.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. 41 pp. 8vo., with two county maps. *By N. H. Winchell.* Published in the Regents' Report for 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. 162 pp. 8vo.: with four county maps and a number of other illustrations. *By N. H. Winchell,* assisted *by M. W. Harrington* Also published in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. 8vo. 248 pp ; four colored maps and several other illustrations *By N. H. Winchell.* Also published in the Regents' Report for 1876, with Reports on Chemistry by *S. F. Peckham*, Ornithology by *P. L. Hatch*, Entomology by *Allen Whitman*, and on Fungi by *A. E. Johnson*.

The Sixth Annual Report on the Geological and Natural History Survey, for the Year 1877. Three geological maps and several other illustrations. 226 pp. 8vo. By *N. H. Winchell*, with Reports on Chemical Analyses by *Prof. Peckham*, on Ornithology by *P. L. Hatch*, on Entomology by *Allen Whitman*, and on Geology of Rice County by *L. B. Sperry*. Also published in the Regents' Report for 1877.

The Seventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1878. With twenty-one plates. 123 pp. 8vo., by *N. H. Winchell*, with a Field Report by *C. W. Hall*, Chemical Analyses by *S. F. Peckham*, Ornithology by *P. L. Hatch*, a list of the Plants of the north shore of Lake Superior by *B. Juni*, and an Appendix by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota. Also published in the Regents' Report for 1878.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 178 pp. 8vo. One plate of Castoroides. *By N. H. Winchell*, containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, descriptions of new species of brachiopods from the Trenton and Hudson River formations; the Geology of Central and Western Minnesota, by *Warren Upham*; report on the Lake Superior region by *C. W. Hall*; lists of Birds and of Plants from Lake Superior by *Thomas S. Roberts*; Chemical Analyses by *S. F. Peckham*; Report by *P. L. Hatch*; and four Appendixes. Also in the Regents' Report for 1879 and '80.

THE NINTH ANNUAL REPORT OF THE SURVEY FOR THE YEAR 1880. Three appendixes, two wood cut illustrations, and six plates. 8vo. 392 pp., by *N. H. Winchell*, containing field descriptions of 442 crystalline rock samples, with notes on their geological relations, from the northern part of the State; new brachiopoda; the water supply of the Red River Valley, with simple tests of the qualities of water; Reports on the Upper Mississippi Region by *O. E. Garrison*, on the Hydrology of Minnesota by *C. M. Terry;* on the Glacial Drift and its Terminal Moramis by *Warren Upham;* chemical analysis by *J. A. Dodge;* a list of the Birds of Minnesota by *P. L. Hatch*, and of the Winter Birds by *Thomas S Roberts.* Also in the Regents' Report for 1879 and 1880.

II. MISCELLANEOUS PUBLICATIONS

1. CIRCULAR NO. 1. A copy of the law ordering the survey, and a note asking the co operation of citizens and others 1872.
2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham*
3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. A history of all official transactions relating to them, and a statement of their amount and location. 1874. *By N. H Winchell.*
4. A CATALOGUE OF THE PLANTS OF MINNESOTA; prepared in 1856 by *Dr. I. A. Lapham*, contributed to the Geological and Natural History Survey of Minnnesota, and published by the State Horticultural Society in 1875.
5. CIRCULAR NO. 2. Relating to Botany, and giving general directions for collecting information on the flora of the State. 1876.
6. CIRCULAR NO. 3. The establishment and organization of the Museum. 1877.
7. CIRCULAR NO. 7. Relating to duplicates in the Museum and exchanges. 1878.
8. THE BUILDING STONES, LIMES, CLAYS, CEMENTS, ROOFING, FLAGGING, AND PAVING, STONES OF MINNESOTA. A special report by *N. H. Winchell*, 1880.
9. CIRCULAR NO. 5. To Builders and Quarrymen Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum. 1880.
10. CIRCULAR NO. 6. To owners of mills and unimproved water powers. Relating to the Hydrology and water-powers of Minnesota. 1880.

ERRATA.

Page 42. Third line—for *sawthuth*, read Sawteeth.
56. Twelfth line—for *tubes*, read talus.
65. Twenty-third line—for *tract*, read trail.
67. Seventeenth line—for *vein*, read rim.
89. Twelfth line—for *land*, read hand.
99. Twenty-fourth line—for *Merabi*, read Mesabi.
119. Twenty-ninth line—after *trilobite*, add a foot note, as follows: **Conocephalites minor Shu.?*
133. Twenty-sixth line—for *conspicuous*, read calciferous.
134. Fifth line from the bottom—for *Sendrogroptus*, read *Dendrograptus*.
147. Twenty-sixth line—for *oppressed*, read appressed.
175. Sixth line—after *p.* 417, add in 1871.
187. Thirtieth line—for *have*, read has.
191. Eleventh line—for *steepry*, read steeply.
239. Fifteenth line—for *apicata*, read *spicata*.

PLATE I.

Sketch Map of the Canoe-trail from Ogishke Muncie Lake to the mouth of Poplar river.

Route of N. H. Winchell in 1879.

PLATE I. 10th Annual Report Geological and Natural History Survey of Minnesota.

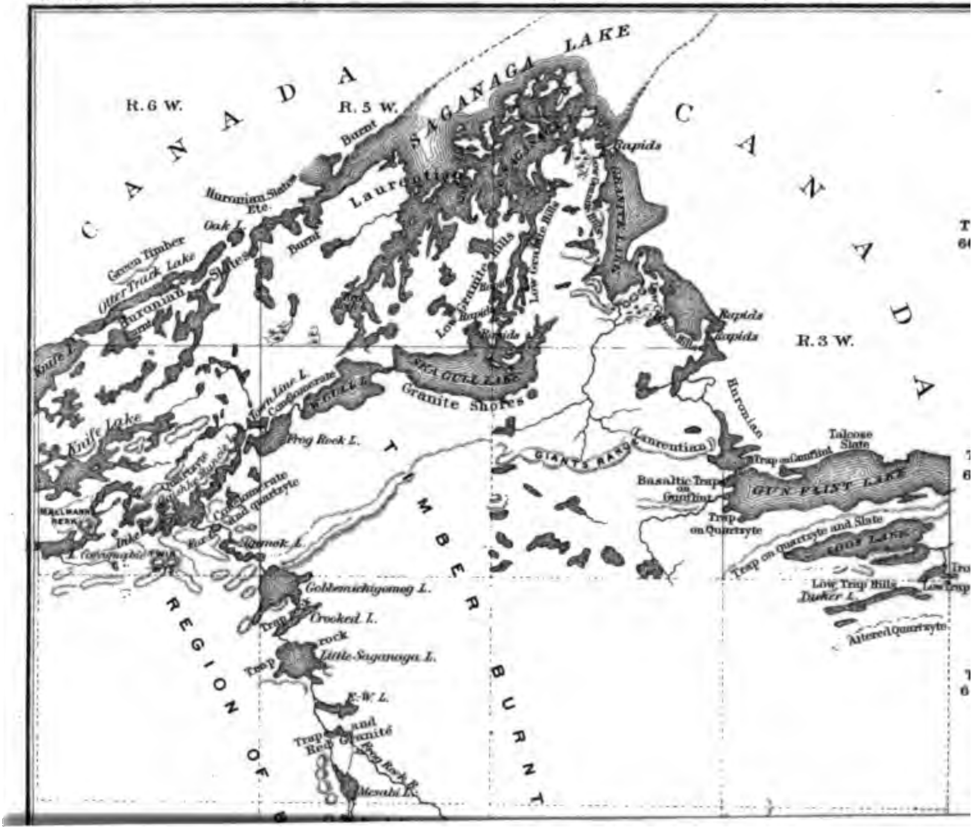
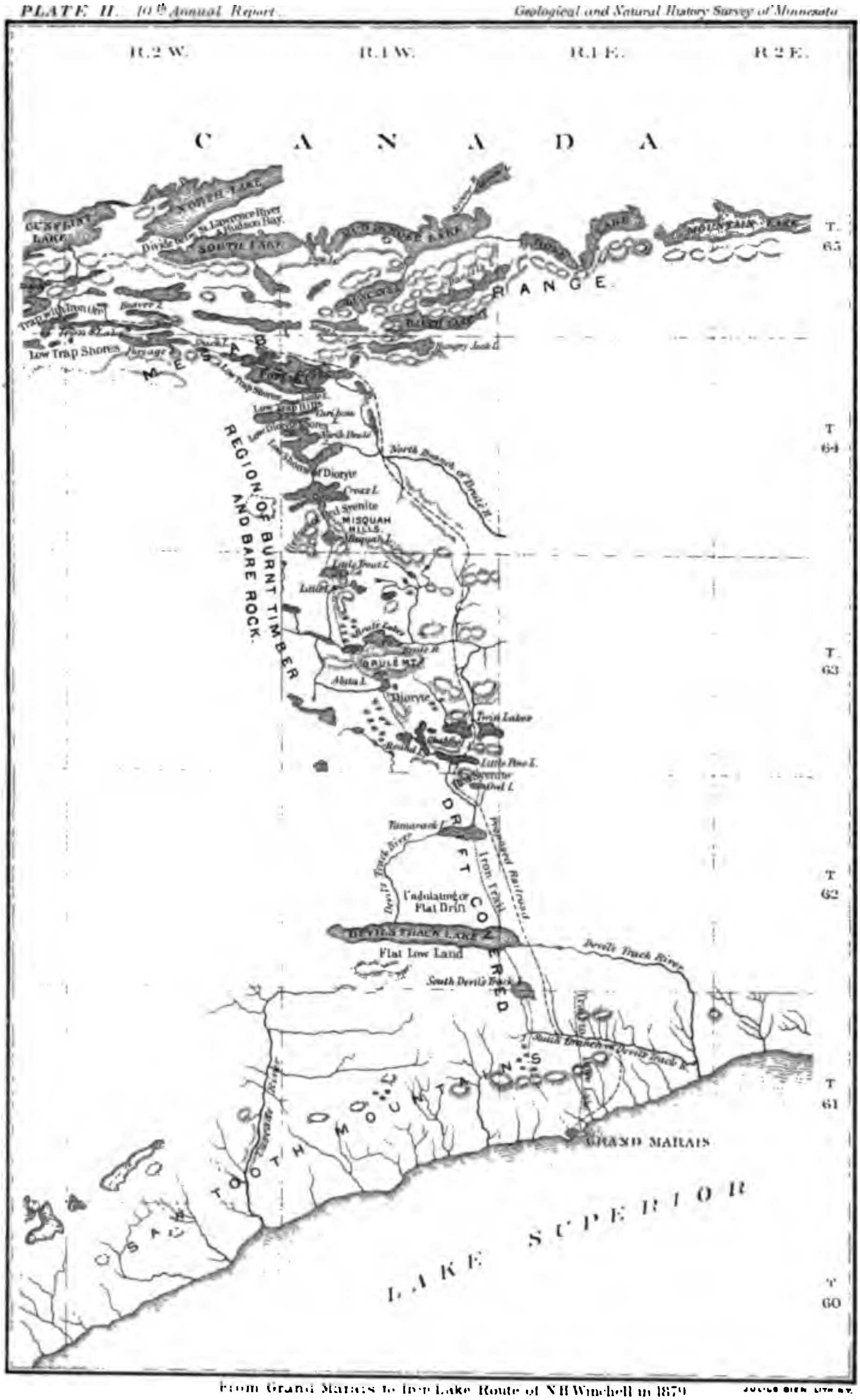


PLATE II.

Sketch Map of the Iron-trail for Canoes from Grand Marais to Iron Lake.

Route of N. H. Winchell in 1879.

PLATE II. *10th Annual Report.* *Geological and Natural History Survey of Minnesota.*



From Grand Marais to Iron Lake Route of N.H. Winchell in 1879.

JULIUS BIEN. LITH. N.Y.

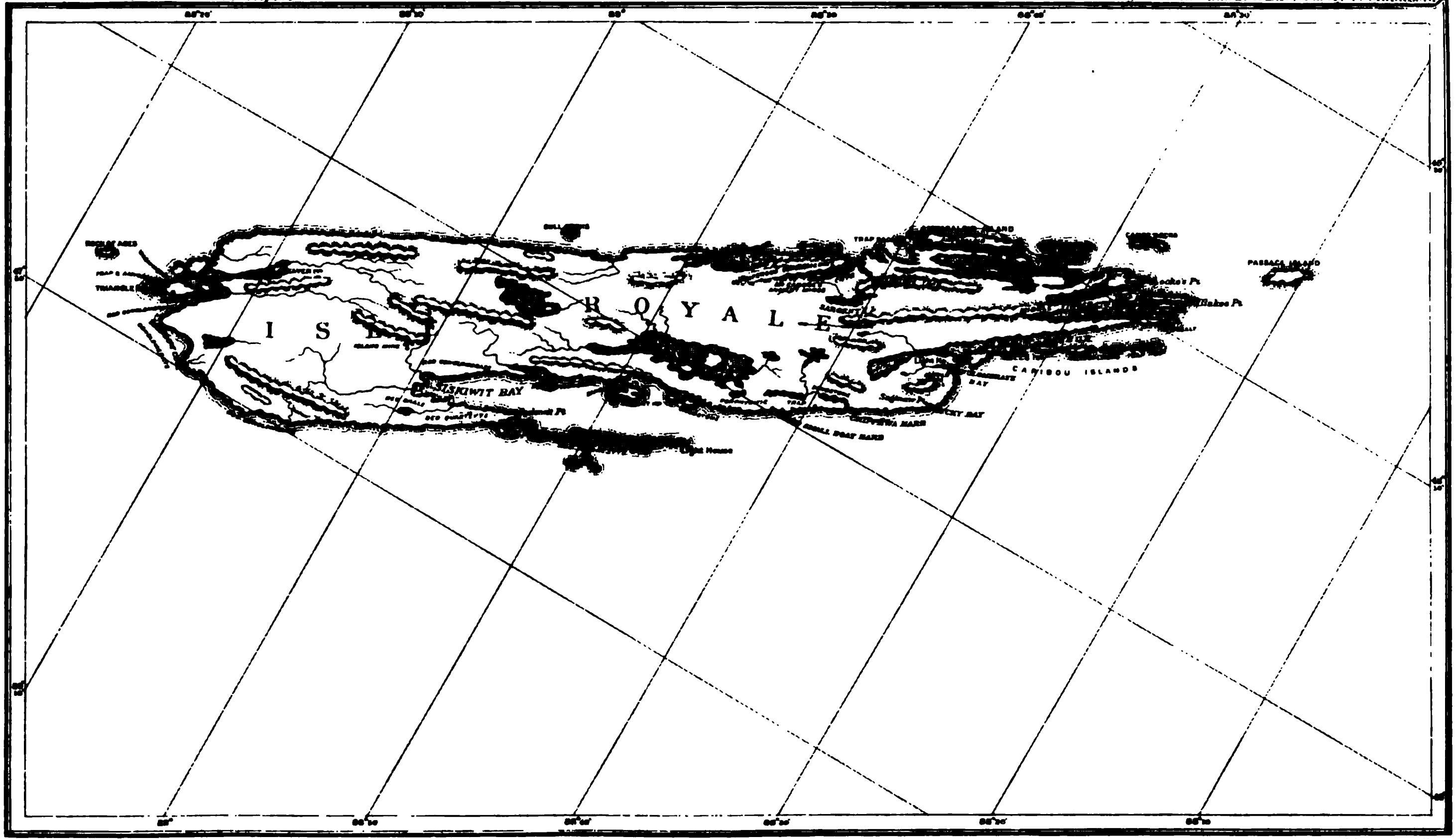
PLATE III.

Sketch Map of Isle Royale

To illustrate notes on the Geology by N. H. Winchell in 1879.

PLATE III. 10th Annual Report

Geological and Natural History Survey of Minnesota



Julius Bien lith. N.Y.

PLATE I.

Diaptomus castor.

1. Male, antennæ not yet fully developed, showing shell, gland, heart, reproductive, alimentary and muscular systems.
2. Female, antennæ and appendages removed except fifth feet.

3 and 4. Nauplius stage.

5. Male foot of fifth pair, (a) "thumb" of larger branch.
6. Female foot of fifth pair.
7. Mouth parts etc.

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10th Annual Report *PLATE I.* *Geol. & Nat. Hist. Sur. Minn.*

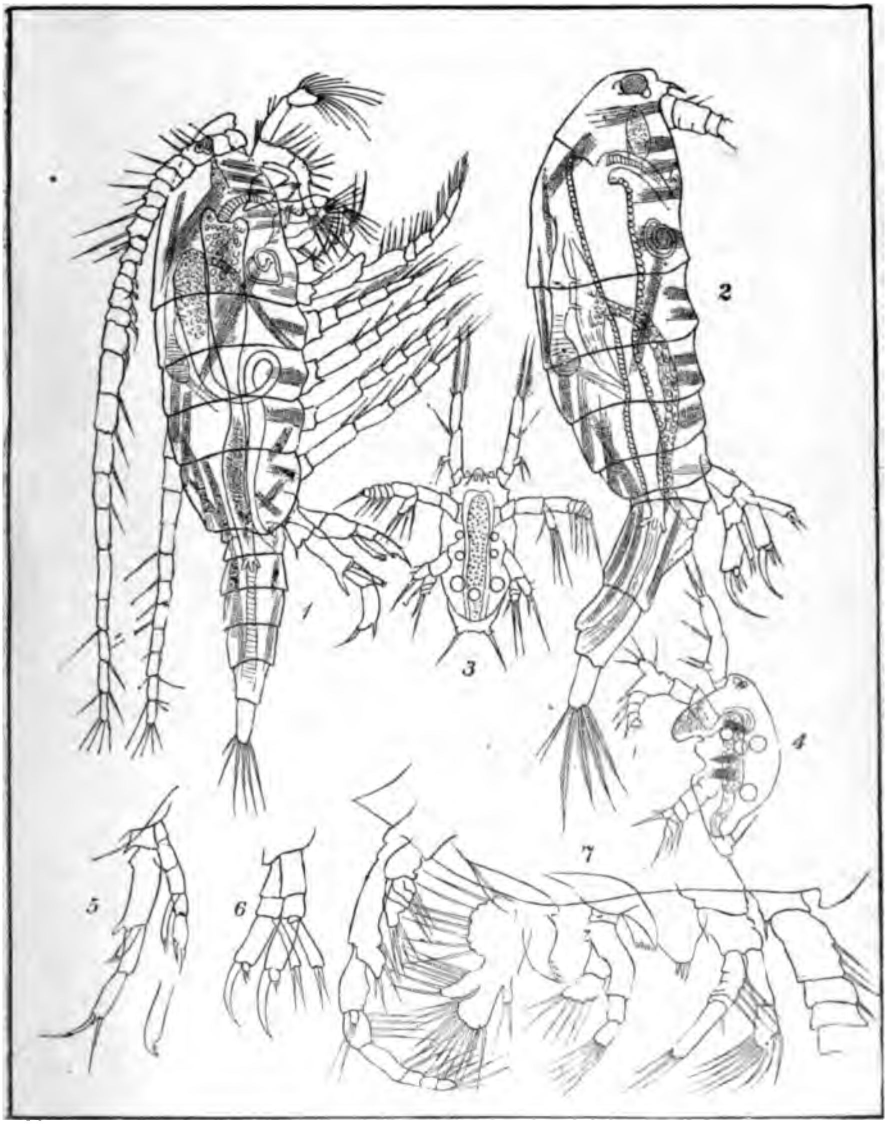

PLATE II.

Diaptomus castor.

1 End of male antennæ.
2. End of abdomen.

Diaptomus giganteus.

3. Caudal stylet.
4. One pair of feet.
5. Maxilliped.
6. Maxilla.
7. Mandible and palp.
8. Antennule.
9. Male fifth foot.
10. Female fifth foot.
11. Spermatic tube.

Potomoichetor fucosus.

12. Female fifth foot.
13. Female abdomen and egg-sac.
14. Abdomen of young.
15. First foot of *Diaptomus giganteus*, one branch drawn reverse.
16. " " *castor*, " " "

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10th Annual Report *PLATE II.* *Geol. & Nat. Hist. Sur. Minn.*

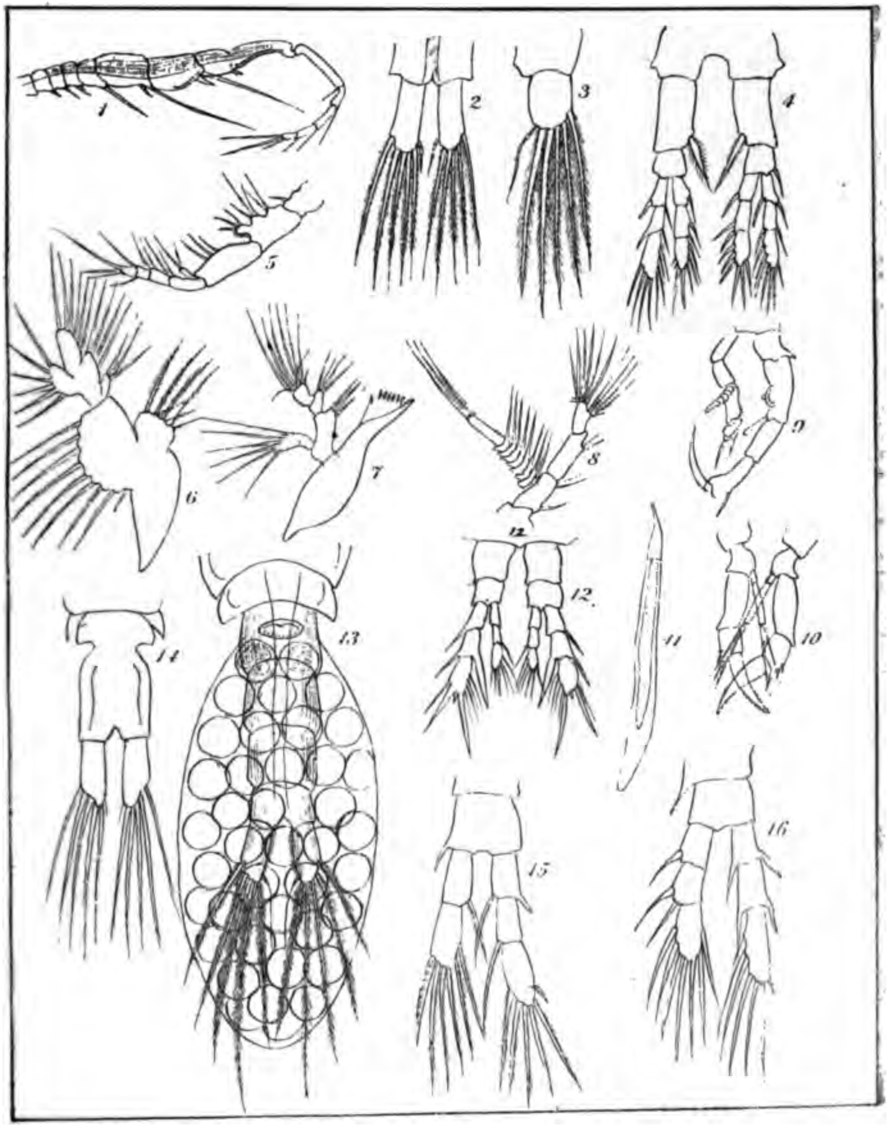

PLATE III.

Potomoichetor fucosus.

1. Male.
2. Antennule.
3. Maxilliped.
4. Male fifth pair of feet.
5. Palp of mandible.
6. End of abdomen.
7. Feet of first pair.
8. Eye.

Cyclops ater.

9. Female
10. Abdomen.
11. Maxilliped.
12. Antenna.
13. Maxilla of *Potomoichetor fucosus.*
14. Mandible of " "

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PLATE III.

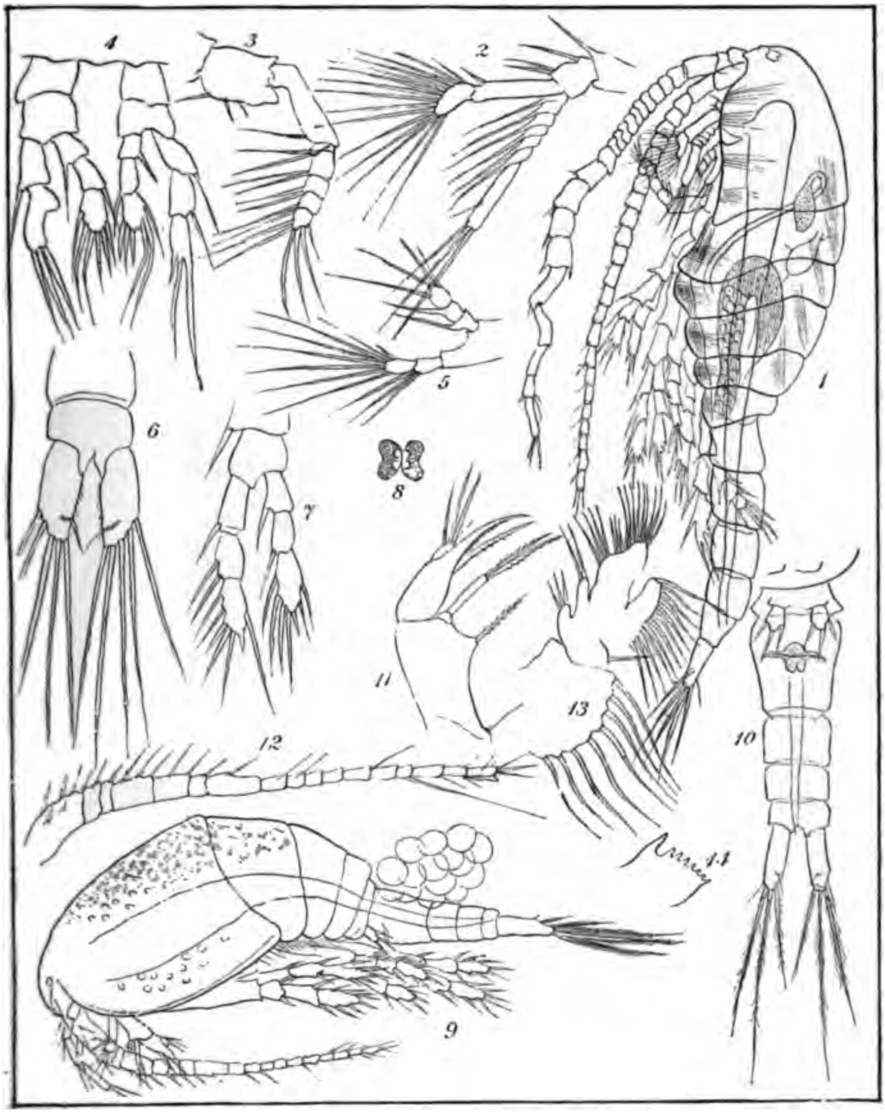

PLATE IV.

Cyclops ingens.

1. First segment of abdomen of female.
2. Antenna.
3. Fifth foot.
4. Antenna of young male.
5. Stylets of mature female.
6. " young male.
7. Maxilliped.
8. Mandible.

9. *Cyclops crassicornis*, Female.

10. Antenna.
11. Terminal portion of abdomen.
12. Female fifth foot.
13. Second antenna.
14. Nauplius form.

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PLATE IV.

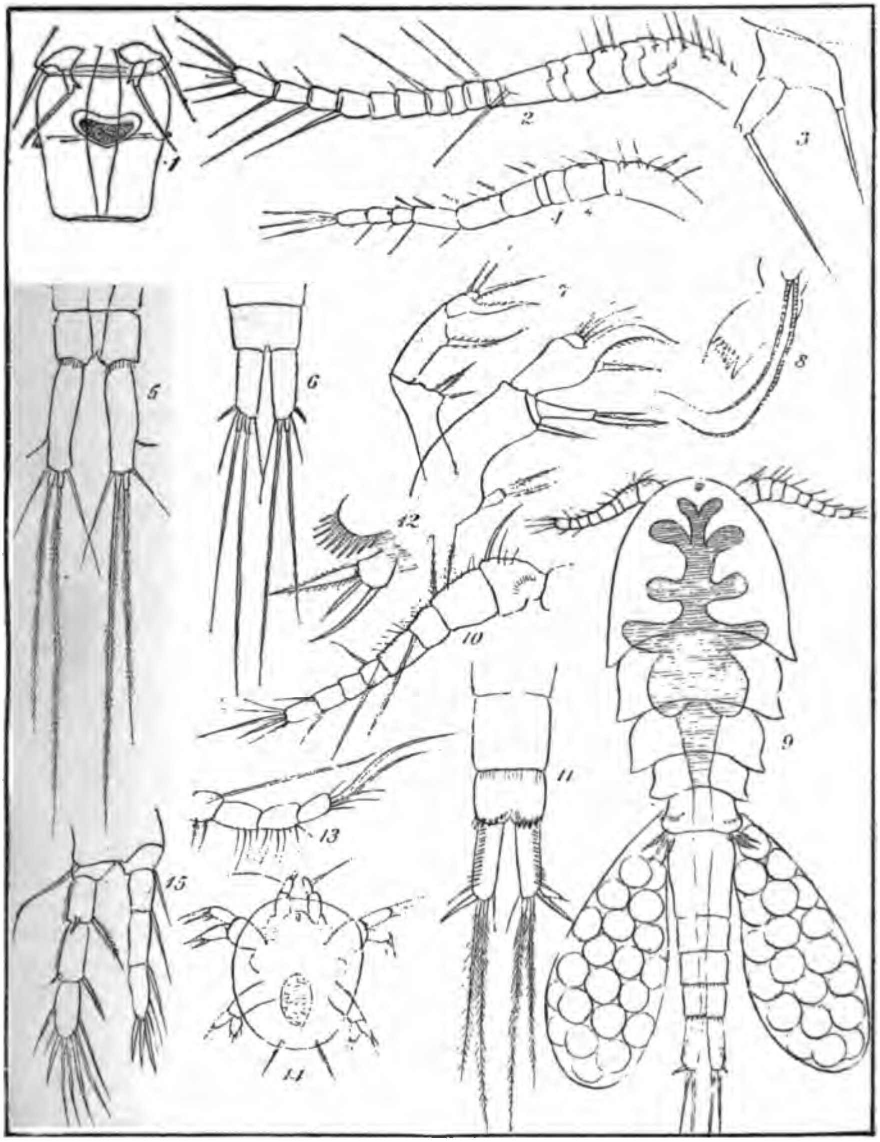

PLATE V.

Cyclops serrulatus.

1. Female.
2. Antenna of elongated form.
3. Stylet of ordinary form.
4. Antenna of very young.
5. Stylet of elongated form.

6. *Cyclops navus*, antenna.

7. Furca.
8. Abdomen of young.
9. Abdomen of male.
10. Opening of spermatophore.
11. Fifth foot.
12. Antenna of young.
13. " male.

14. *C.* "*signatus*," maxilliped.
15. *C. navus*, swimming foot of first pair.
16. " " " second pair.
17. Maxillipeds.

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PLATE V.

Geol. & Nat Hist. Sur. Minn.

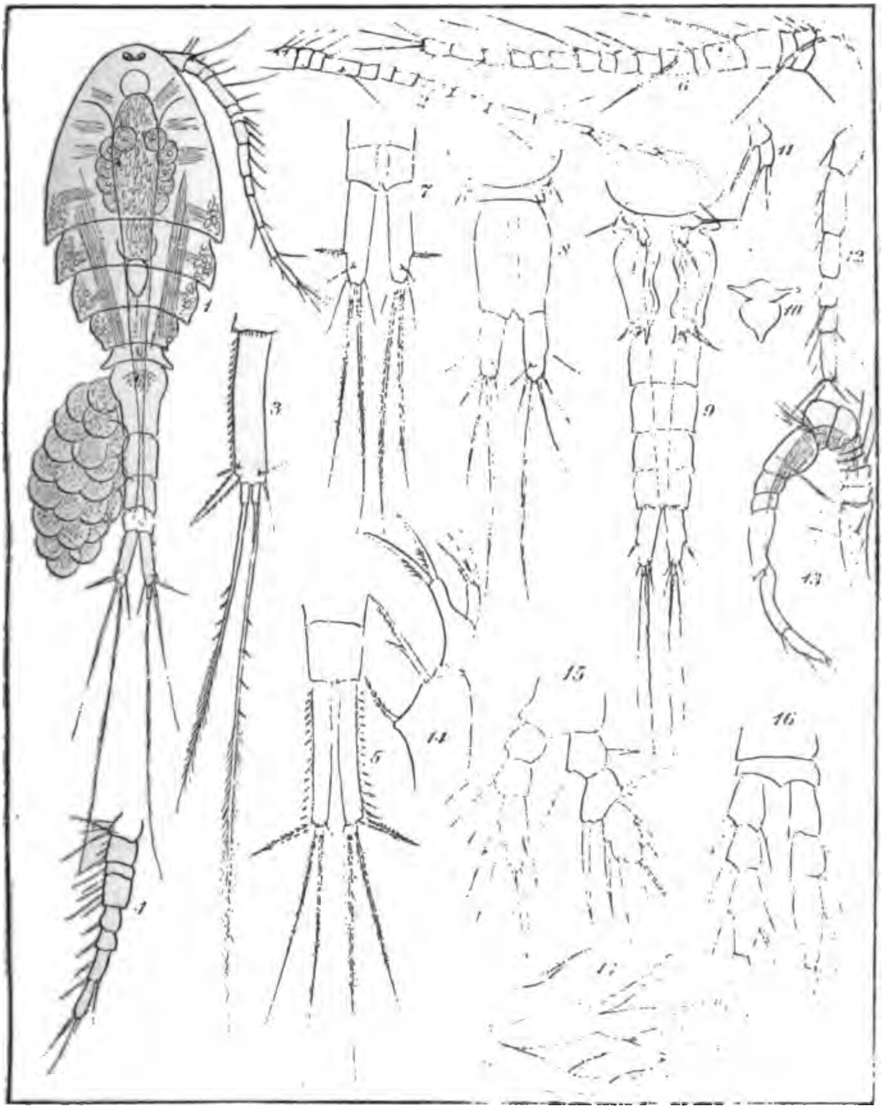

PLATE VI.

Cyclops tenuicornis.

1. Female.
2. Mandible
3. Maxillæ.
4. Stylet.
5. Fifth foot.
6. Maxillipeds.
7. Antennule.

C. "*signatus.*"

8. Abdomen.
9. Antenna.
10. Fifth foot.
11. Male antenna.

Cyclops parcus.

12. Abdomen.
13. Antenna
1 . Fifth foot.

Cyclops adolescens.

15. Opening of spermatophore.
16. Abdomen.
17. Foot.
18. Female antenna.
19. Eye.
20. Male antenna.
21. End of antenna of a form of *C.* "*signatus.*"

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PLATE VI.

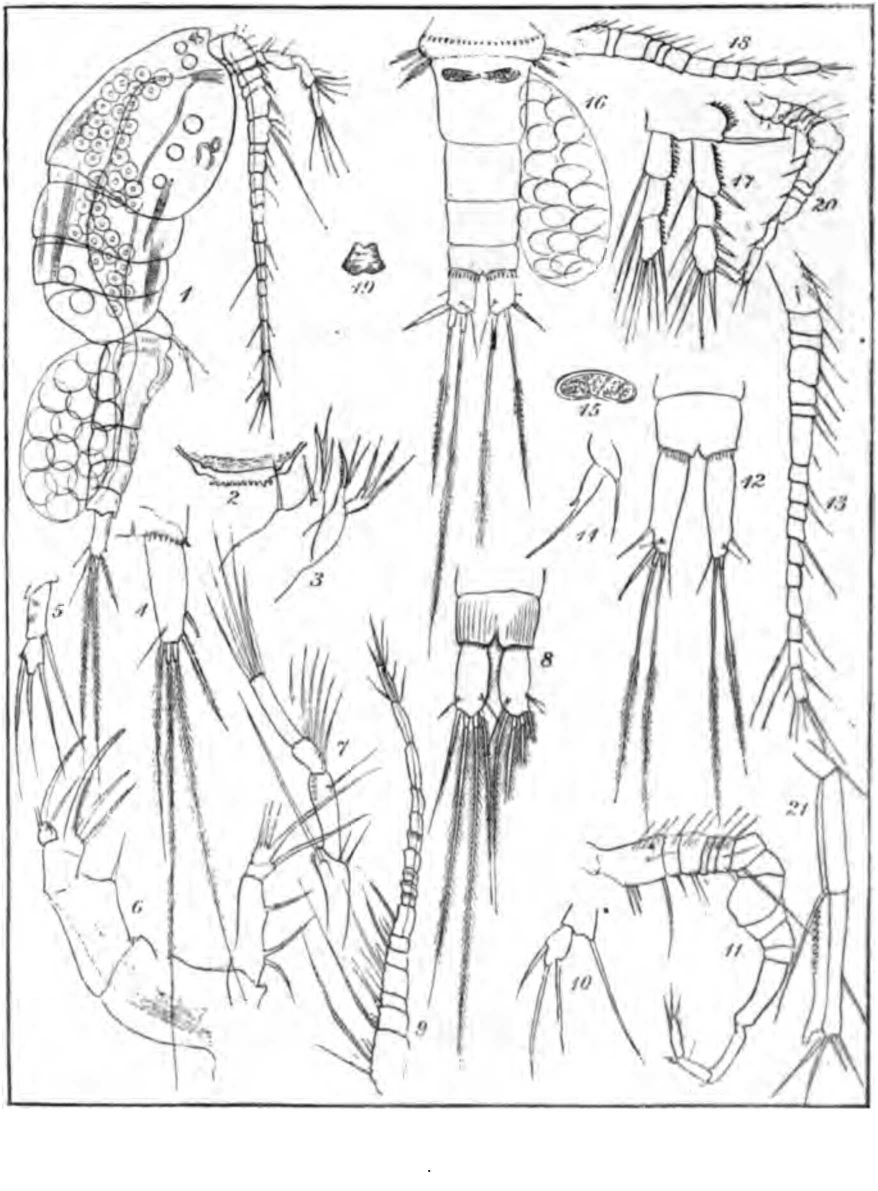

PLATE VII.

1-9. *Cyclops fluvialitis.*

3. Antenna of young. 4. Abdomen of young. 10. Young of *C. serrulatus.*

11. *Daphnella brachyura*, female. 14. End of male abdomen.

12. " " male. 15. End of female abdomen.

13. Part of edge of valves. 16. Antenna of male.

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PLATE VII.

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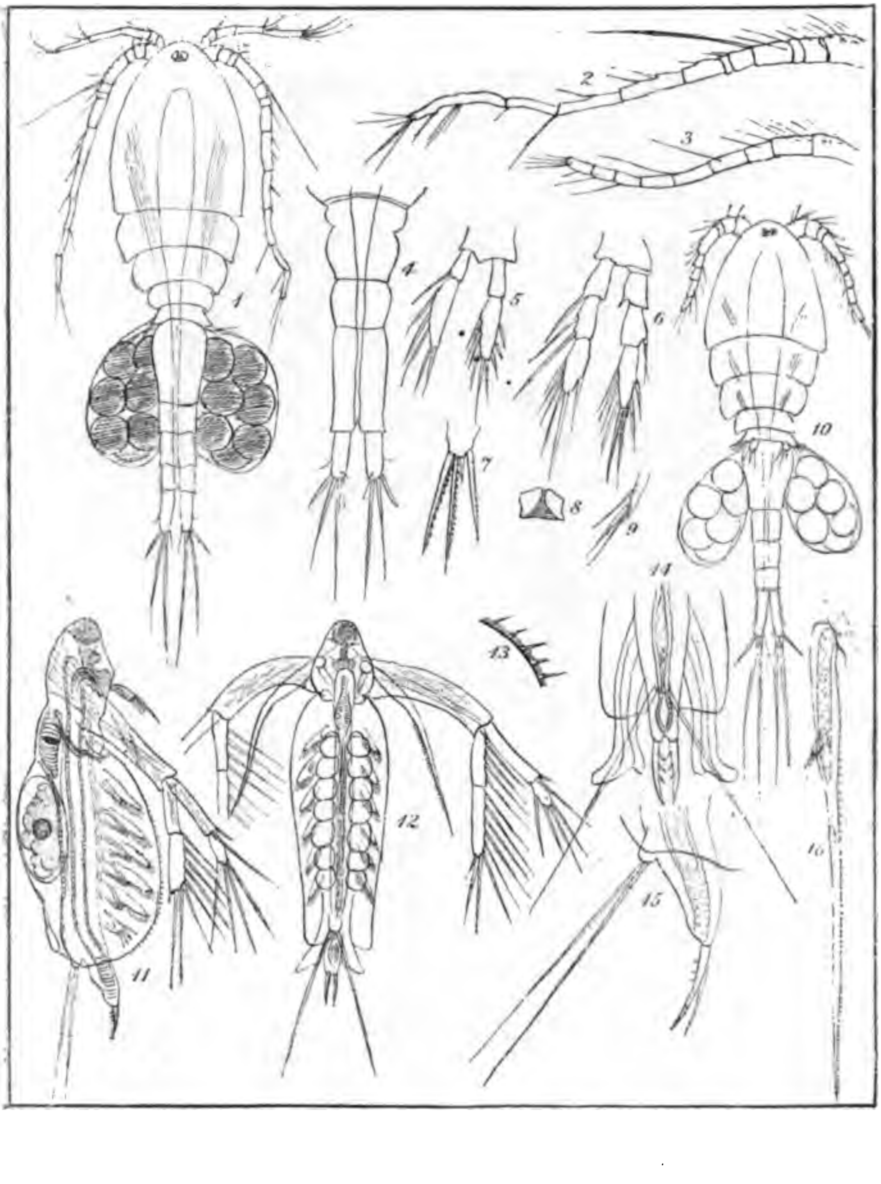

PLATE VIII.

1. *Macrothrix pauper*,
2–6. *Iliocryptus spinifer*.
7–8. *Leydigia quadrangularis*
9–10. *Camptocercus rotundus*.
11–12. *Lathonura rectirostris*.

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PLATE VIII.

Geol. & Nat. Hist. Sur. Minn.

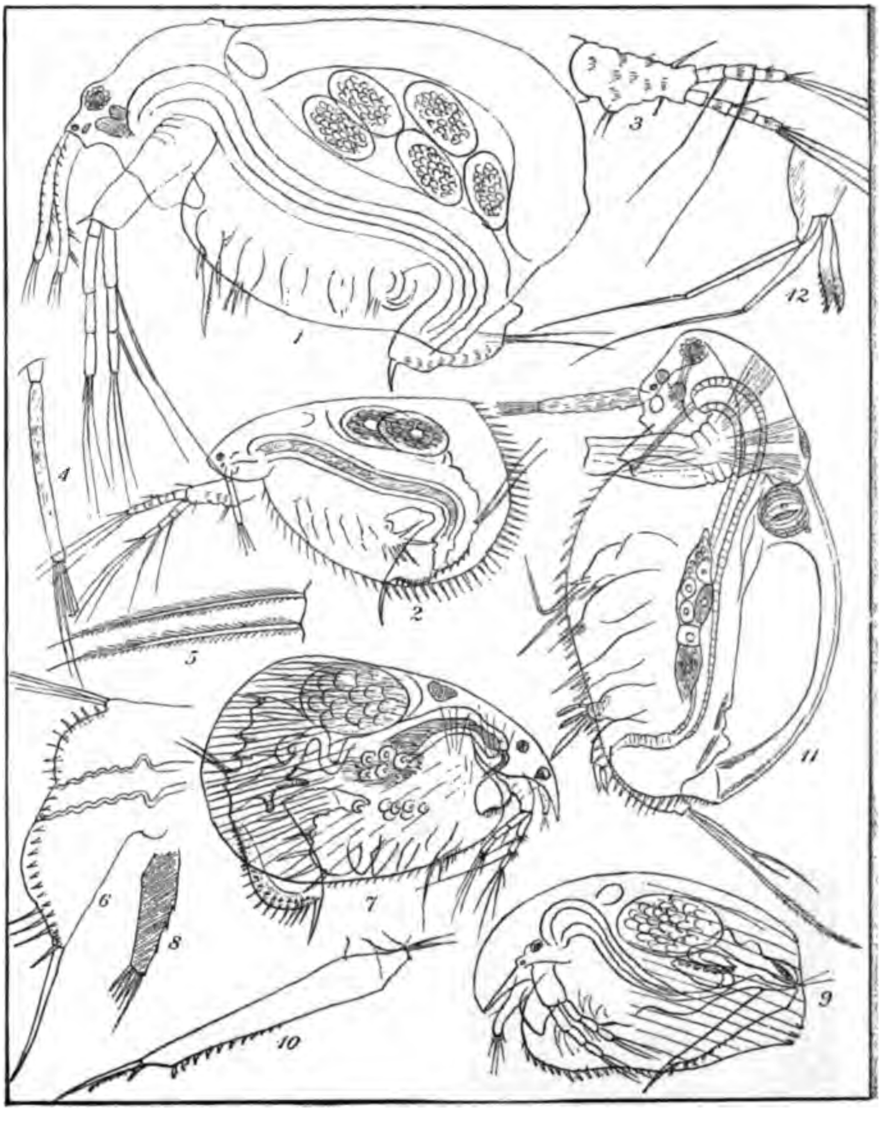

PLATE IX.

1–3. *Lyncodaphnia macrothroides.* 4–6. *Polyphemus pediculus*

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PLATE IX.

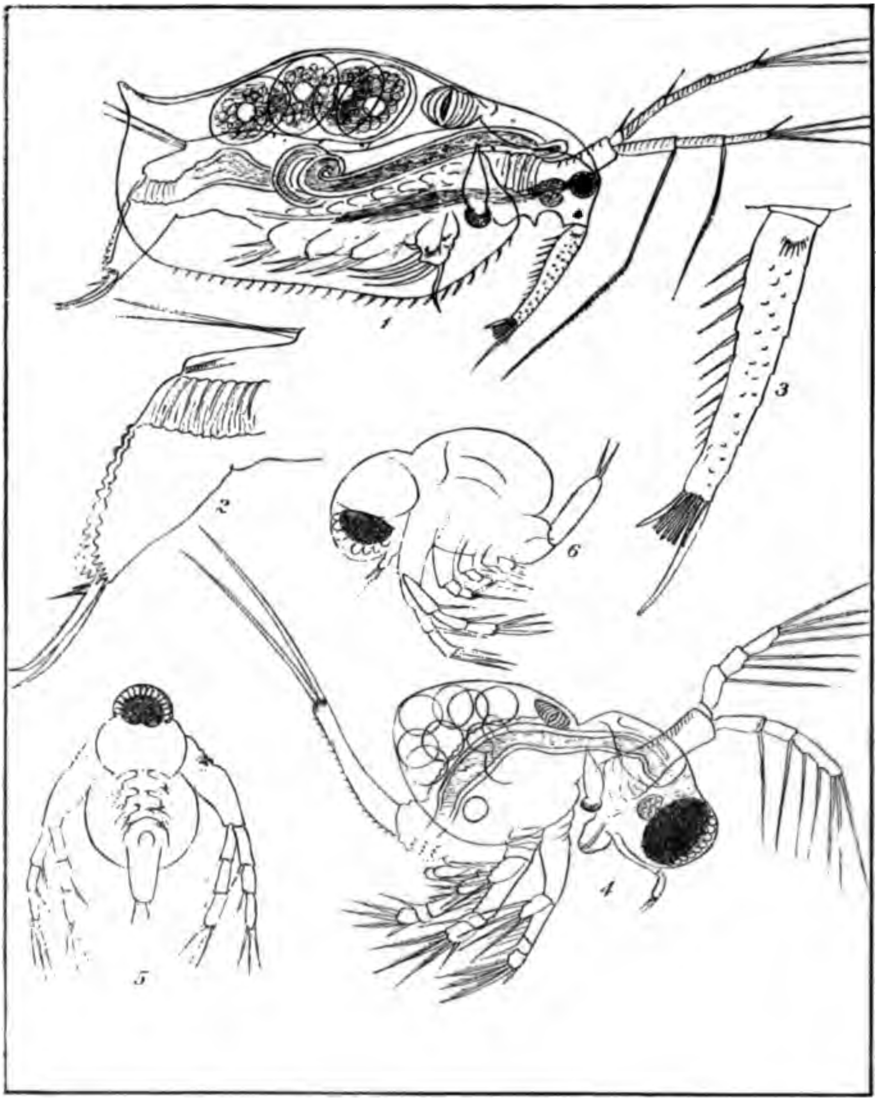

PLATE X.

1.	*Bosmina striata.*
2.	" *longirostris.*
3-5.	" *cornuta.*
6-7.	*Pleuroxis procurvatus.*
8.	*Graptolebris inermis.*
10.	*Acroperus sp?*
11-12.	*Graptolebris inermis.*

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PLATE X.

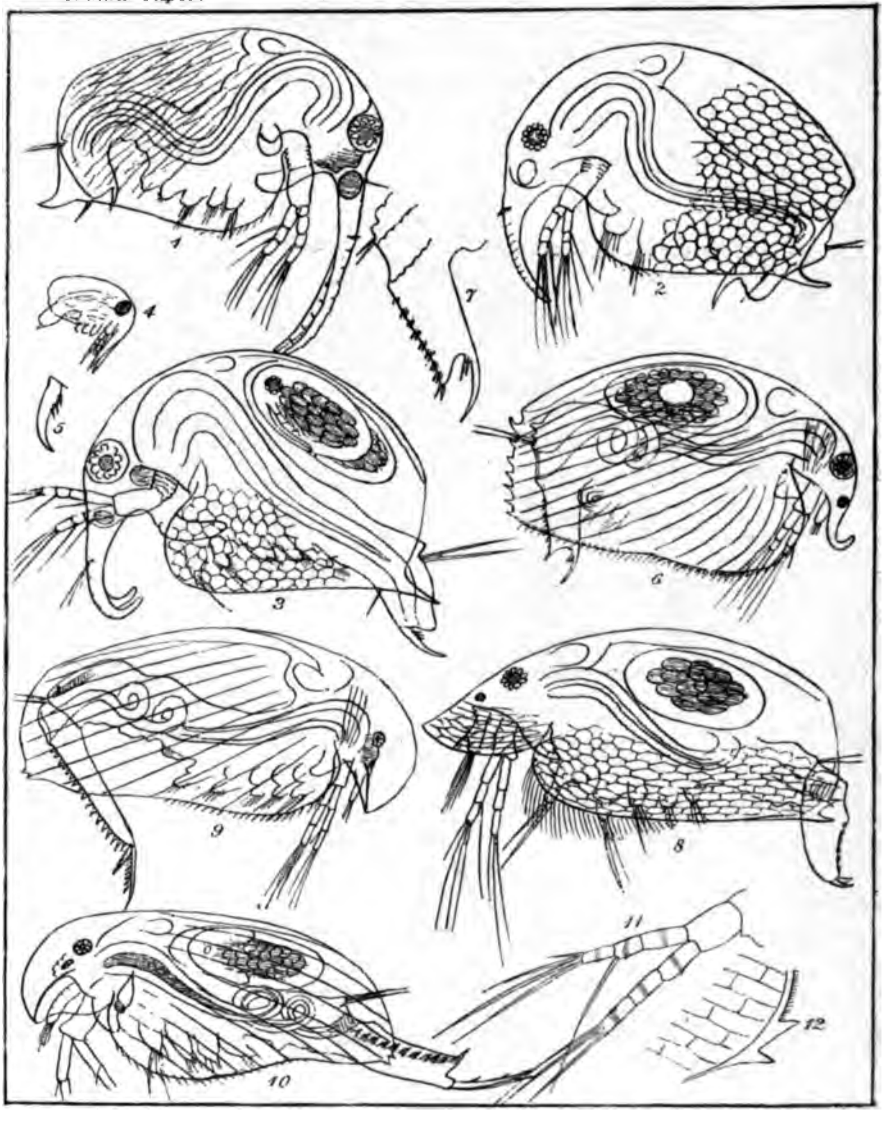

PLATE XI

1. *Limnetes* sp ? male.
2. First foot of male.
3. Antenna.
4. Mandible.
5. Maxilla.
6. Mandibler teeth.
7. Caudal appendages of female.
8. Head, labrum etc., of female.
9. Antenna (2d) of female.
10. Foot of female.
11. Exterior of whole animal from in front.
12. Modified (sexually) foot of female.
13. End of process of same.
14. Magnified spines of lateral limbs of same.
15. Daphni sp. ?
16. Daphni sp. ?

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